

**ETI**

for Electronics & Computing Enthusiasts

# Electronics Today

INTERNATIONAL

December 1983

**\$2.75**  
MM70924  
Testing Electronic  
Mail

## Batteries



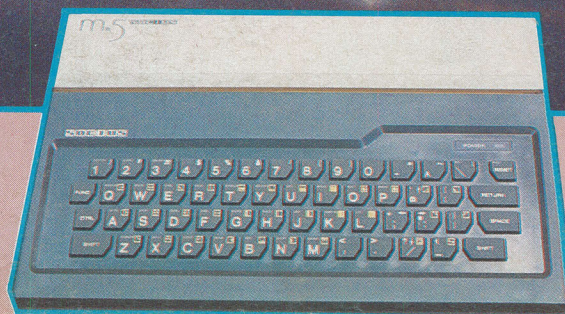
**Which Battery to Use? optimize battery life ...**

**NiCad Regenerator ... restore their health ...**

**Voltmeter ... and monitor them.**

**50 More Computers!**  
**Middle to high-end**

**Sord Socius M5  
Computer  
Review**





# EXCELTRONIX (416) 921-8941 1-800-268-3798

**Bulletin Bd. (416) 921-4013 Telex 065-24218**

Catalog shipping rates are incorrect. Please call us for correct charges.

## Monitors **NEW**

**Zenith ZVM-123 Green**  
**\$129**

**zenith ZVM-122 Amber \$195**

**Amdek Colour-1 \$395**

**Amdek Amber - 300A \$259**

## Multiflex Intelligent Terminal

(As Reviewed in Oct. '82 ETI)

An excellent low cost terminal kit from **\$195**

Assembled & Tested with case and P/S

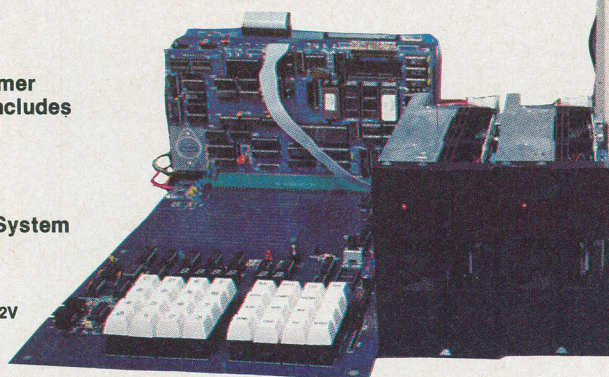
**\$350**

## Multiflex **KIT** ONLY \$995 **Super System**

- S100 Based
- Z-80A Processor
- runs CP/M
- EPROM Programmer
- BASIC Package includes
- CPU card w. 64K
- Video Board
- Disk Controller
- SA455 Drive
- CP/M Operating System

### OPTIONS

Power Supply: 5V 4A,  
12V 2A, -5V 0.5 A, -12V  
0.5A \$99  
Keyboard  
(no case) \$99



## Memory Chips

4164 - 150 ns (1x64K single (+5V) supply)	8.44
4116-200ns (1x16k)	1.74
4116-150 ns (1x16k)	1.99
2114L-200 ns (1kx4 static)	2.49
6116-150 ns (2kx8 static RAM)	8.94
(Pin compatible with 2716 uses negligible amount of power)	
2016-150 ns (2kx8 static)	8.74
2102L-200 ns (1kx1 static)	1.94
5101-CMOS RAM	3.84
2708-(1kx8) EPROM	6.74
2716-(2kx8 EPROM single +5V)	4.94
2732-(4kx8 EPROM single +5V)	7.94
2532-(4kx8 EPROM single 5V)	8.74
2764-(8kx8) EPROM single 5V)	11.94

**WE HAVE A  
SPECTACULAR  
STOCK OF  
74LS PARTS  
AT  
REASONABLE  
PRICES.  
OEM  
ENQUIRIES  
INVITED**

## Diskettes

5 1/4" Diskettes Boxes of 10	
Maxell MD-1 .....	\$36.00
Maxell MD-2 .....	\$52.95
Verbatim .....	\$34.00
CDC .....	\$27.95
Dysan .....	\$33.95
3M .....	\$32.95
Ectype (with library case worth \$4.95) .....	\$27.44
2 Ectype Diskettes in a plastic binder sheet .....	\$5.89
SPECIAL Free calculator when you purchase 5 boxes of 3M diskettes.	

## Joysticks

Self-Centering	<b>\$39.95</b>
With two adjustable controls Super offer	
Kraft Joystick	<b>\$69.00</b>
TG Joysticks	
DeLuxe Model	<b>\$75.00</b>
TG Paddles	<b>\$64.95</b>
De Luxe Model	
Deluxe Table Top Model	<b>\$59.00</b>

**Special**

**Featuring the  
Multiflex Apple™  
Compatible Drive**

**1 YEAR WARRANTY  
1000'S SOLD  
AN EXCELLENT  
CHRISTMAS GIFT  
IDEA**



**only  
\$269**

**Also available at \$299**  
with 90 day warranty!

- Teac Slim Drive
- Micro-Sci Drive
- SA400L Mechanism
- Quentin Drive
- Siemens Mechanism
- ATI FDD-810 Slim Type

**Controller \$89**

Coming Soon  
Commodore & IBM  
peripherals!

### PRICE POLICY

Remember that at Exceltronix all prices are negotiable for quantity purchases. If you cannot afford large quantities on your own how about starting a Co-op.

**CHARGE**

### MAIL ORDERS

Send a certified cheque or money order (do not send cash). Minimum order is \$10 plus \$3 minimum for shipping. Ontario residents must add 7% provincial sales tax. Visa, Mastercard and American Express accepted: send card No., signature, expiry date and name of bank.



Head Office: 319 COLLEGE STREET, TORONTO, ONTARIO. CANADA. M5T 1S2 (416) 921-8941

Circle No. 7 on Reader Service Card.



**BEFORE YOU BUY ANY IBM COMPATIBLE  
PRODUCTS; CHECK WITH US FIRST. FOR BEST  
PRODUCTS AND PRICES.**

**1-800-268-3798 (416) 921-8941**

**Telex 065-24218**

**EXCELTRONIX wishes you a Merry Christmas.  
"Christmas Specials"**

**November Software Specials**

Castle Wolfenstein	\$34.95
Wizardry	\$47.95
Knight of Diamonds	\$36.97
Ultima II	\$64.95
Pinball Construction	\$42.95
Suspended	\$46.95
Chess, Odesta	\$74.95
Cosmic Balance	\$39.95
Miner 2049'er	\$38.95

Witness	\$42.95
Sea Dragon	\$41.00
Evolution	\$39.00
Apple Panic	\$36.00
Frogger	\$41.00
Flight Simulator	\$48.00
Pinball	\$39.00
Fork I	\$39.00
Deadline	\$48.00
Ulysses	\$47.00
Temple of Apshai	\$46.50

Locksmith	\$125.00
DOS Tool Kit	\$89.00
Crosswire	\$36.50
Screen Writer II	\$159.95
Lisa	\$119.95
Zaxxon	\$49.95
Computer Baseball	\$39.00
David's Midnight Magic	\$39.00
Typing Tutor II	\$24.95
Flip 'n File 50	\$39.00

**NEW Book Specials**

Apple Software 1983	\$22.00
The Blue Book	\$26.95
CP/M Assembly Language	
Programming	\$15.00
The Power of Multiplan	\$17.95
A User Guide to the Unix System	\$20.00
Motorola CMOS Data	\$12.95
Motorola Linear Data	\$12.95
TTL Data Book	\$14.00



**NEW  
\$359.00**

**Gemini 10X**

8½", Dot Matrix,  
80 Column, 120  
c.p.s. Regular  
price \$615.



**PRINTER SPECIALS**

**Gemini 15X**

**\$699**

15", Dot Matrix, 132 column, 100 c.p.s.

**EPSON MX80FT**

**\$795**

8½", Dot Matrix with GRAFTRAX +

**EPSON MX100**

**\$995**

15", Dot Matrix with GRAFTRAX +

**EPSON RX80 (NEW)**

**\$495**

Replaces MX80

**EPSON FX80 (NEW) \$798**

8½", Dot Matrix, 80 column, 160 c.p.s.

**TTX PRINTER**

**\$789**

Daisy Wheel

PDA-232 RS232

**\$119.00**

WIZARD BPO-16, Apple  
Compatible

**\$184.00**

16K parallel buffer printer card

Wizard — IPI parallel intelligent  
printer interface **\$85.00**

**PAPER \$10.45**

For your printer

Control Data, 9½" x 11" plain, 500  
sheets Other sizes available.

**RF MODS \$18.00**

Applesoft Tutorial \$14.44  
DOS Manuals \$25.00

**SA455 Disk Drive**

Half Height, Double Sided,  
IBM Compatible

**\$349**

**EMP Mini Modem**

300 Baud, Direct Connect Regular Price \$199

**Special Price \$124**

**Smart Modem**

300 Baud, Direct Connect

**Special Price \$399**

**Micro Modem \$459**

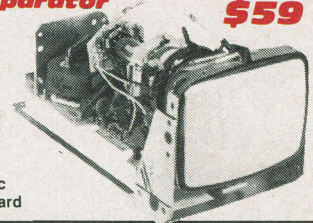
300 Baud, Direct Connect Plugs into Apple™

**5" Green Screen Monitors  
Sync Separator  
Kit \$59**

**\$9.95**

Open frame.  
Requires 12V.  
Ideal for 6502  
computers.

Requires Sync  
Separator Board



**CHRISTMAS GIFT CERTIFICATES AVAILABLE.  
AN EXCELLENT GIFT FOR THE COMPUTER ENTHUSIAST!**

**16K RAM Card**



**\$55.00**

Expand you 48K APPLE to 64K. The  
MULTIFLEX 16K RAM Card allows other  
languages to be loaded into your Apple  
from disk or tape. Allows APPLE CP/M  
users to run CP/M 56.

**Multiflex EPROM  
Programmer \$69**

**FEATURES:**

- \*EPROM programmer for APPLE com-  
puters.
- \*Programmes 2716, 2732, 2732A, 2764.
- \*ZIF socket for the EPROM.
- \*Complete with software.
- \*Built-in programming supply.

We have a large selection of books and  
magazines

**PROTO BOARDS \$14.00**

**80-Column Card**

**FEATURES:**

- \*Gives 80 columns and upper/lower case  
on your APPLE II/II + /Ile computer.
- \*Works with PASCAL and CP/M.
- \*Auto-switch between 40 columns and 80  
columns.
- \*Full inverse video.

**\$74**

**Z-80 Card**

- \*Runs CP/M on your Apple
- \*You can run hundreds of professional  
software packages
- \*Software not included.

**\$58**



**Exceltronix Computer Division Computers at unbeatable  
prices! (416) 921-8941, 319 College St., Toronto, Ontario**

**M5T 1S2**

**EXCELTRONIX**

No returns or exchanges after 7 days. 15% restocking charge.



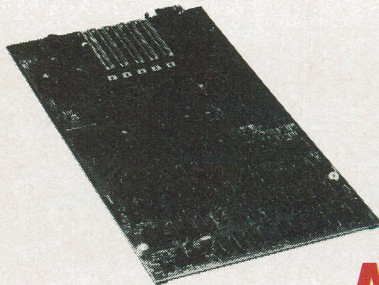
# SURPLUSTRONICS

**we will not be undersold**



## OUR FAMOUS 6502 BOARD

NOW NEW & IMPROVED VIDEO SECTION



This 6502 board is a vast improvement on others available:

- 64K RAM (8-4164 chips)
- 80 x 24 video included on board
- Floppy Disk Controller included
- FIVE additional slots
- Z80 blank PCB included
- Powerful power supply (5V 5A, +12V 2 up to 3A peak, -5V 0.5A, -12V 0.5A)
- Hydro-approved whereas many others are not!
- Superb quality plastic case
- Excellent keyboard including numeric keypad
- EPROMS (blank) included
- High QUALITY pc board
- Excellent service
- Now at a reduced price \$599 kit
- Available in Kit. Available preassembled (with all sockets, conn, & discrete, flow soldered & cleaned. IC's to be inserted by user not tested) only \$29. on top of kit cost.
- Complete assembled & tested (blank EPROMS) **\$689**

**NOW**

you receive a **FREE** Z80 PC BOARD AND **FREE** 128K RAM DISK PC BOARD when you order the complete package (either Kit or A&T) (BLANK

## 6502/8088 Board

**CALL FOR PRICING**

**NEW**

## 8088 BOARD

**COLOUR GRAPHICS**  
256K RAM or 1MEG. using new 256K RAM Chips.

- Floppy controller • I/O • And much more
  - Sold with all parts including blank EPROMS • Compatible with ???
- Yes you guessed it. At a price so low you won't believe it. Please call for ordering & pricing. Demand is overwhelming. Orders will be filled (On a first come first served basis).

TO BE RELEASED OCT. 30

CALL FOR PRICES

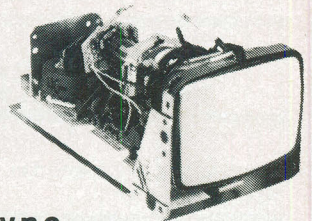


**CALL FOR PRICING**

**We have the Best Prices on IBM Peripheral Boards and Cases. Also our own 8088 Boards with most Peripherals on Board. Check with us before you buy anywhere else.**

## 5" Green Screen Monitors. \$59

Open frame.  
Requires 12V.  
Ideal for 6502 computers.



Requires Sync  
Separator Board

**KIT \$9.95**

## Peripherals for your APPLE™

16K RAM Card - complete A&T **\$55.00**  
Eprom Programmer- A&T with software to program 2716, 2732, 2732A and 2764. **\$69.00**  
Z80 Card - (no software) A&T **\$57.00**  
80x24 Video Board (runs CP/M & Pascal) **\$73.00**  
Wizard Printer Interface card with Epson personality Eprom (works great with GEMINI 10X) Complete **\$79.00**

Our own Printer interface card A&T with blank personality Eprom **\$49.00**  
128K RAM Disk A&T (no software) **\$199.00**  
APPLE™ Compatible Disk Drives attractively packaged, ready to plug in **\$269.00**  
Disk Drive Controller A&T **\$79.00**  
Our Disk Drive Controller, A&T, with two blank 2716's **\$49.00**

GEMINI 10X Printers **\$359.00**  
Wild Card provides back-up copies of protected software with just the push of a button **\$139.00**  
Our Crazy Card provides back-up copies of protected software with just the push of a button **only \$59.00**  
PDA 232 **\$118.00**

Mail Orders add \$3.00 minimum for shipping & handling. Ontario residents add 7% P.S.T. Visa, Mastercard and American Express cards accepted: send card number, expiry data, name of bank and signature. Send certified cheque or money order, do not send cash.  
This month only, we will ship free of charge to Ontario Residents only.

**Huge variety of Surplus stock at low, low prices. New shipments arriving. No reasonable offers refused.**

Circle No. 22 on Reader Service Card.

Surplustronics, 310 College Street, Toronto, Ontario, M5T 1S3 (416) 925-8603.

1-800-268-3798

(416) 925-6558



# ETI Electronics Today

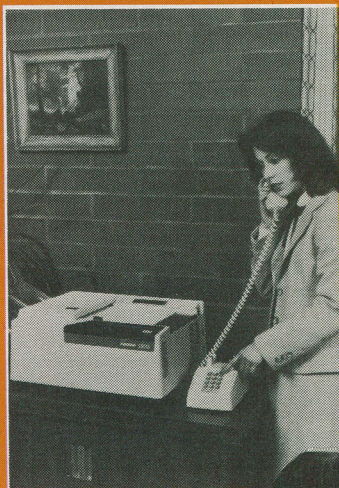
INTERNATIONAL

December 1983  
Vol. 7 No. 12  
ISSN 0703-8984

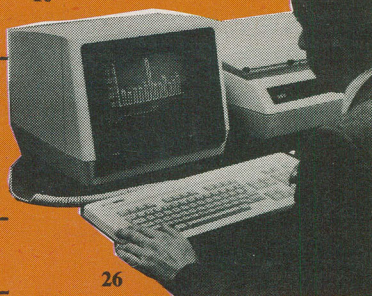


## Our Cover

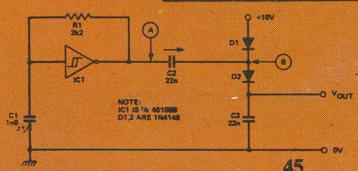
Various batteries and related circuits are covered in this issue; photo by Bill Markwick. The Sord M5 is reviewed on page 39; photo by the Unknown Editorial Assistant.



10



26



45

## 60 Playmate Part 2

In which we finish up constructional details of this instrument amp and (blush) correct an error in the original schematic.

## Features

### 10 Electronic Mail

Will high-tech eliminate getting envelope glue on your tongue? Roger Allan reports on mail-by-satellite.

### 15 Which Battery To Use?

If your flashlight goes dead too soon, light a candle and read this guide to selection.

### 26 50 More Computers

We continue last month's survey with a look at the jazzier but pricey high-end models.

### 34 Designing Microsystems, Part 4

The bootstrap start-up.

### 38 Product Review

The Brother EP-20 Electronic Typewriter.

### 39 Computer Review: Sord Socius M5

Rubber keys meet dynamite BASIC graphics.

### 45 Designer's Notebook

Voltage multipliers: get a 250,000 volt lightning blast from a hearing aid battery. For those who dare.

### 50 Nuclear Applications in Archaeology

Roger Allan presents a scientific examination of pottery from the grave and skeletons from the closet.

### 64 Computing Today

VIC-20 Graphics Listing.

### 68 Book Review

Mathematics for Electronics.

## Projects



### 20 NiCad Charger/Regenerator

Don't throw out those apparently dead NiCads. Chances are they can be revived with this project.

### 23 Expanded Scale Voltmeter

Keep an accurate eye on battery packs and power supplies with this 10 to 15 V meter project.

## Columns, News and Information

For Your Information .. 6      Order Form ..... 55  
Next Month ..... 19      Subscriptions ..... 56

ETI Specials ..... 73  
Fun of Electronics ..... 66  
Classifieds ..... 74  
ETI Binders ..... 78  
ETI Bookshelf ..... 57  
Tech Tips ..... 71

## ADVERTISERS' INDEX

Active Components Sales Corp.	65
Allan Crawford & Associates	76,77
A.P. Products	80
Arkon Electronics	71
Audiovision	17
BCS Electronics	37
Brunelle Instruments Inc.	35
C&H Electronics Plus	12
Daetron	32
Electronic Control Systems	65
Electronic Packaging Systems	35
Exceltronix	2,3
Fastron	33
Fujicomp Inc.	75
General Electronics	49
Gentek Computers Inc.	32
H. Rogers Electronic Instruments	54
Innovative Electronics & Devices	21
Interfax Systems Inc.	79
I&S Software Library	65
JLS Computers	49
JMT Inc.	49
Kitstronic International Ltd.	24
McGraw Hill	29
Metermaster	44
Micro Computech Electronics Ltd.	40,41
Nielsen Computers Inc.	47
Orion Electronic Supplies	8,9
Parts Galore	22,69
Protec Microsystems Inc.	72
Sattelite Systems Ltd.	65
Surplustronics	4

NEWSSTAND DISTRIBUTION:  
Master Media, Oakville, Ontario

### SUBSCRIPTIONS

\$18.95 (one year), \$33.95 (two years). For US add \$3/yr., other countries add \$5/yr. Please specify if subscription is new or a renewal.

### BINDERS

Binders made especially for ETI are available for \$9.25 including postage and handling. Ontario residents please add provincial sales tax.

### BACK ISSUES AND PHOTOCOPIES

Previous issues of ETI Canada are available direct from our offices for \$4.00 each; please specify by month, not by feature you require. See order card for issues available.

We can supply photocopies of any article published in ETI Canada; the charge is \$2.00 per article, regardless of length. Please specify both issue and article.

### COMPONENT NOTATION AND UNITS

We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!

Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.

Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.6ohms is 5R6.

### PCB Suppliers

ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs. Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

K.S.K. Associates, P.O. Box 266, Milton, Ont. L9T 4N9.

B—C—D Electronics, P.O. Box 6326, Stn. F, Hamilton, Ont., L9C 6L9.

Wentworth Electronics, R.R.No.1, Waterdown, Ont., L0R 2H0.

Danocinths Inc., P.O. Box 261, Westland MI 48185, USA.

Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont. M5V 2A5.

Beyer & Martin Electronic Ltd., 2 Jodi Ave., Unit C, Downsview, Ontario M3N 1H1.

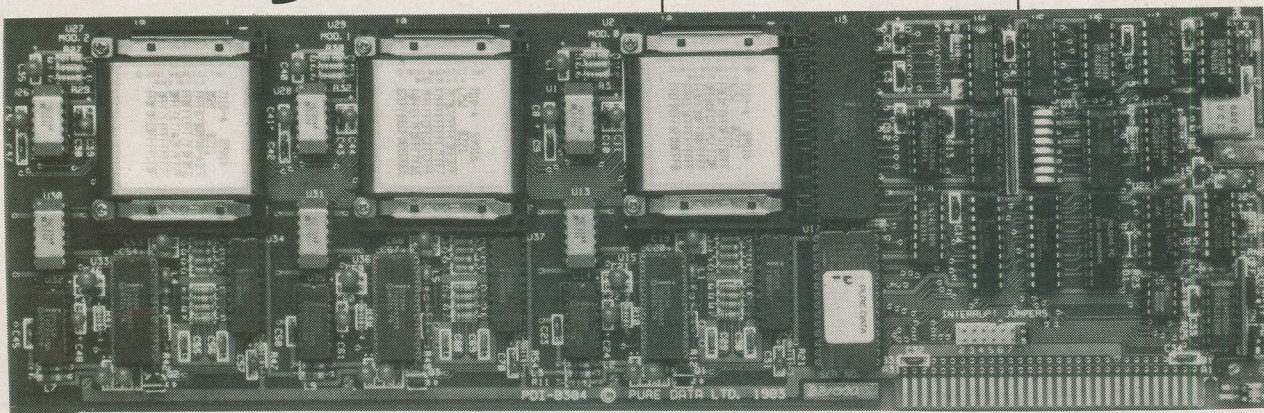
Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

### POSTAL INFORMATION

Second Class Mail Registration No.3955. Mailing address for subscription orders, undeliverable copies and change of address notice is: Electronics Today International, Suite 601, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.



# for your information



## ETI Magazine is Published by:

**Moorshead Publications**  
Editorial and Advertising Offices  
Suite 601, 25 Overlea Boulevard,  
Toronto, Ontario, M4H 1B1  
Telephone (416) 423-3262

**Publisher:** Halvor W. Moorshead  
**Editor:** Bill Markwick  
**Editorial Assistant:** Anthony DeBoer  
**Production Manager:** Ann Rodrigues  
**Production:** Susan Cross  
Robin Mills-O'Neill  
Doug Goddard  
Earl Gunawardena  
**Circulation Manager:** Lisa Salvatori

**Accounts Department:** Pirjo Dunphy  
**Advertising:** Omar Vogt  
**Representatives:** Rick May  
**Advertising Traffic**  
**Co-ordinator:** Claire Zyvitski  
**Advertising Services:** Carolyn Wyatt  
Sharon Cernecca  
**General Manager:** Senga Harrison  
**Executive**  
**Vice-President:** V. Kenneth Marskell

## COPYRIGHT

All material is subject to worldwide copyright protection. All PCB patterns are copyright and no company can sell boards to our design without our permission.

## LIABILITY

While every effort has been made to ensure that all constructional projects referred to in this magazine will operate as indicated efficiently and properly and that all necessary components are available, no responsibility whatsoever is accepted in respect of the failure for any reason at all of the project to operate efficiently or at all whether due to any fault in the design or otherwise and no responsibility is accepted for the failure to obtain component parts in respect of any such project. Further no responsibility is accepted in respect of any injury or damage caused by any fault in design of any such project as aforesaid.

## Editorial Queries

Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letters ETI-Query. We cannot answer telephone queries.

## PC Bubble Card

EcoSea Technologies Corp. has announced the release of the world's first magnetic-bubble memory card for the IBM PC and IBM PC-XT.

The Pure Data PDIB128 and PDIB384 provide either 128K or 384K respectively, of non-volatile memory storage using only one slot of the IBM backplane. Unlike a floppy disk, the cards are entirely solid-state, with no moving parts. This means that the devices are impervious to dust, dirt, fumes or vibration.

Another first is the feature of password protection in hardware. The end users can create their own

password to provide the ultimate in security for their PC system. Once created, the password can be used to "lock-up" either the computer itself, the bubble card only, or both devices. This password protection cannot be bypassed by any means, and no method exists to "read" the password.

Used as a virtual disk drive, the bubble card is many times faster than a floppy disk drive, and much more reliable. The bubble card operates as a standard DOS 2.0 disk-type device, is compatible with all DOS software, and does not require any patching of system files. The PDIB128 and the PDIB384 use two

I/O lines and no memory space. Both DMA and interrupts are supported, but not required.

Comprehensive diagnostic software and other utilities are provided free of charge with the card, along with a full illustrated installation and operation manual.

EcoSea Technologies Corp., 465 King Street East, Unit 13, Toronto, Ontario M5A 1L6 (416) 366-1000 is Canadian distributor for these and other products manufactured in Canada by Pure Data Ltd.

Commodore Computer is hosting The World of Commodore at the International Centre in Toronto, Canada on December 8-11 to mark its 25th anniversary. This is Canada's first truly international computer show, involving hardware and software exhibitors and seminar speakers from 10 countries including West Germany, the United Kingdom, Japan, Sweden, France, Hong Kong and the U.S.A. It is also the first major consumer exhibition mounted by a single manufacturer in Canada.

## Chopper Analyzer

Helicopter maintenance time can be significantly reduced by a British instrument which is capable of analysing rotor performance and offering balance corrections in flight. Eliminating the dangerous, time consuming and often inaccurate conventional methods of assessment, the microprocessor-based Rotortuner uses a low-power short-range radar unit on the body of the helicopter to measure damper performance and blade position. Variations in height and angular displacement are displayed at each selected flight speed. These findings analyse during flight any necessary adjustments to be made to the weights on the blade tips, blade bolts, balance points or blade sweep. As the instrument includes a memory, findings can be combined with known characteristics



of the system, with a trend analysis from one servicing to the next and with data from other aircraft in the production series. It can then recommend the maintenance test procedure to be adopted. By additionally providing a logical sequence for these tests to be carried out and also eliminating any need for reference to data tables and charts, it further reduces maintenance time.

The analyzer is marketed by Helitune Ltd., 16a Reading Rd.

South Fleet, Hampshire, England GU13 9QL Telephone: Fleet (02514) 4798 Contact: David Bloxham, Commercial Director Enquiries from potential customers/agents are welcomed by the company.



# for your information

havior problems in farm animals who come in contact with the equipment.

Most farms will have some degree of tingle related problems, which can result in many problems to the farmer; milk productivity losses, breeding problems, mastitis, pig scours, and general stress reactions are common.



## Tingle Filter

Electricians and contractors in rural areas should recognize the profit potential of this newly developed Tingle Voltage Filter for applications on farms where stray or tingle voltage related animal productivity declines are a problem. Tingle voltage or stray voltage is a phenomenon resulting from small electric potential, usually 2 to 3 volts, being present between grounded metal farm equipment (such as watering troughs, feeders, metal penwork etc.) This potential causes many be-

Until now, the only solutions were expensive or even dangerous: separation of the primary neutral line from the barn neutral greatly increases danger from lightning and can create safety problems; isolation transformers are a good solution but are very costly; equi-potential grid systems are only viable in new barn construction.

The Tingle Voltage Filter is about \$300, and is easily installed at the main pole or at the main barn panel. It will reduce tingle voltage to below 0.2V in most areas. This is well below the threshold of dairy cattle and other farm animals.

Contact: Hammond Manufacturing Company Limited, 394 Edinburgh Road North, Guelph, Ontario, Canada N1H 1E5. Telephone: (519) 822-2960 or (416) 456-3770.

## New PCB DIN's

Preh, a leading manufacturer of DIN connectors for computer and telecommunications applications, has introduced a new line of receptacles that permits peripheral grounding of the inserted connector shell.

The aspect of a reliable ground connection between the DIN receptacle and cord plug is important due to R.F.I. problems in computer applications. The grounding also eliminates the problems associated with static electricity.

Preh, is now represented in Canada by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario, with branch offices in Montreal, Ottawa, Winnipeg, Calgary, and Vancouver.

For further information or to contact: Bruce Petty, at (416) 789-7761.

American Telephone & Telegraph Co. is planning to introduce a microcomputer system within the next six months, according to a new 237-page research report from International Resource Development Inc. The report predicts that the microcomputer will use 32-bit architecture based on Western Electric's Bellmac microprocessor, and that the software will be based upon Bell Laboratories' Unix operating system. The combination of the longer word length (32 bits, as compared with 16 bits on the IBM Personal Computer) and the powerful Unix-based software, will enable the new AT&T microcomputer to "upstage" the IBM PC, according to the report.

AT&T will have difficulty catching up with IBM's lead because of the accelerating production of PCs. "We are aware of specific IBM component and sub-system contracts which point to definite production plans for two million PCs in 1984," says the report, which states that AT&T will be "lucky if Western can manage to make 30,000 of the AT&T micros in 1984."

Bell Laboratories has received its 20,000th patent. World famous as the research and development arm of AT&T, Bell Labs has averaged nearly a patent a day since its founding in 1925, with innovations including long-distance TV transmission in the 1920's, microwave radio transmission in the 30's, the transistor in the 40's, semiconductor electronics in the 50's, communications satellites in the 60's, digital switching in the 70's, and lightwave transmission in the 80's.

The 20,000th patent — another lightwave innovation — is for a new technique, using a gas to etch extremely smooth surfaces on semiconductor compounds which offer advantages over silicon for many devices. The ultra-smooth surfaces are of particular interest for use in tiny lightwave circuits comparable to today's electronic integrated circuits.

The Bank of Montreal has committed to become the first multinational corporation to use Teleglobe Canada's new international private satellite business services. Using a small 4.5 m earth station antenna mounted atop the 72-story First Canadian Place building in Toronto, Teleglobe Canada will provide the Bank with a highly reliable and cost-effective integrated digital communications network, initially between the Bank's offices in First Canadian Place and Bucklersbury House, London, England. The service is scheduled to begin in January.

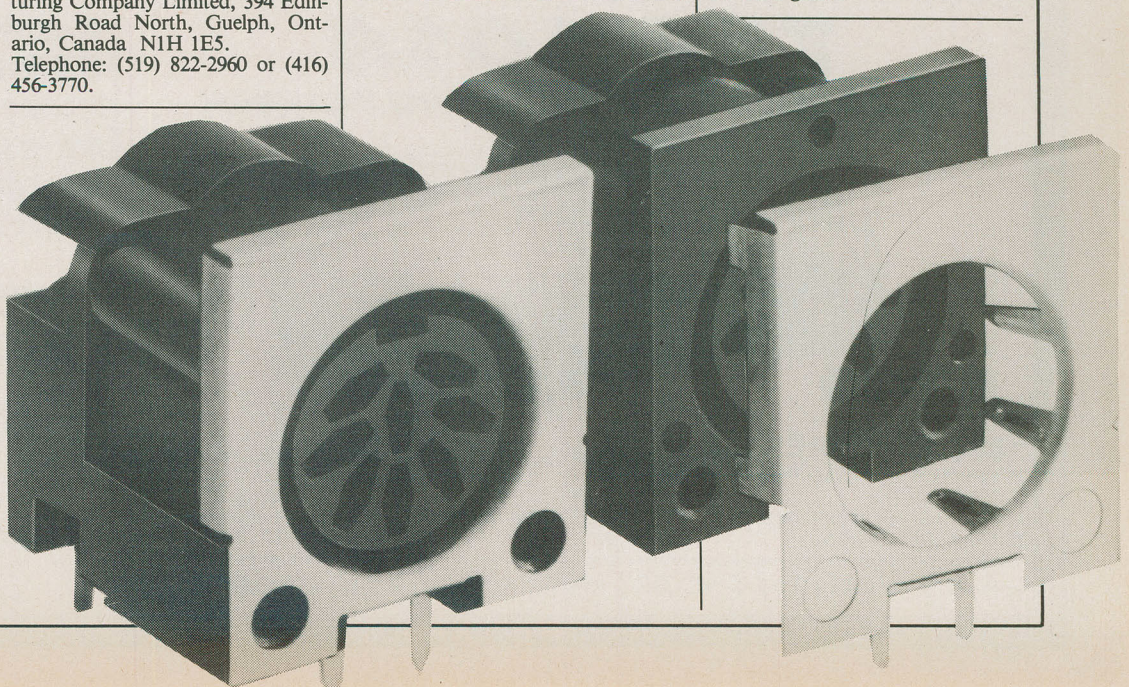
## New Trim Pots

Preh has just released its new Trimming Potentiometer for P.C. board mounting and automatic insertion. Measuring 8.6 mm, it is available in bakelite or Cermet and is completely washable. The wiper assembly is shroud protected and the actuator has an inside taper to accommodate automatic adjustment tools. A choice of hex or cross slot actuators is available, allowing adjustment from either the top or bottom.

For further information, please contact Atlas Electronics, 50 Wingold Ave., Toronto, Ont. M6B 1P7 (416) 789-7761.

The world's first regular broadcast service of computer programs — Telesoftware — is to be started in Britain by the BBC this year (1983). Test transmissions have already been broadcast.

Most of the early programs will be educational ones, intended mainly for use in schools and colleges. Indeed, one of the major suppliers will be the British Government's \$20 million Microelectronics Education Programme, which was set up to train teachers and provide software. Later a full range of programs will be transmitted, for home and business applications, and there will also be video games.





# WINNER: Ultra-modern! Super-efficient!

Please note the distinct features  
Winner offers:

- \*Dual microprocessors 6502 & Z-80A
- \*RS-232 built in
- \*Disk drive interface card built in
- \*40/80 column text display and auto change video output port by soft switch
- \*76K RAM with 4 expansion slots
- \*16K ROM
- \*DOS 3.2 & DOS 3.3 capability
- \*Apple & CP/M compatible
- \*ASCII keyboard with function keys and a numeric keypad

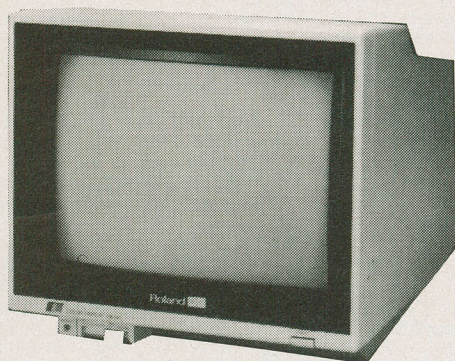
## \$995

- \*Upper/lower case
- \*Streamline case
- \*OS could be changed when desired without affecting other memory RAM



**"ADD VISION TO YOUR COMPUTER WITH THE MICRON EYE"**  
- solid state - programs included - hardware, software & optics included, \$449.00

## Roland CB-141 COLOR B



### \$449.00

Composite System Colour Display

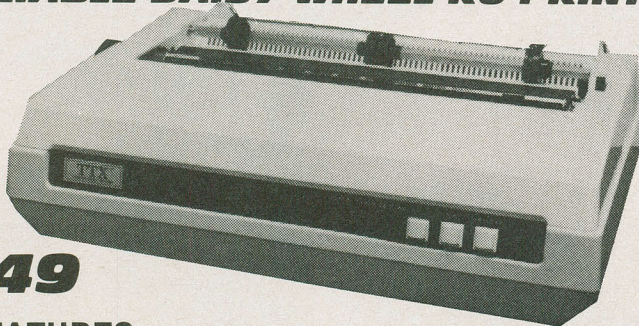
- Composite system, 14-inch display.
- With its built-in amplifier and speaker, it accommodates games, video monitor, etc.
- Low cost but provides high performance with sound circuit & headphone jack.
- Protected from an erroneous operation of a floppy disk drive unit and dealt with a shield treatment for a magnetic interruption against other electronic units.

### Electrohome Monitors & Accessories

EDM926/B&W	\$159.50
9" Black & White monitor	
EDM926/P31	\$169.50
9" P31 Green Monitor	
EDM1226/B&W	\$179.50
12" Black & White Monitor	
EDM1226/P31	\$189.50
12" P31 Green Monitor	
ECM1302-1	\$389.00
13" Color RGB Monitor	
ECM1302-2	\$450.00
13" Color RGB Monitor Hi Rez.	
I-1302	\$ 69.50
NTSC Interface for ECM1302 for Apple II Computers (1 year warranty from Electrohome)	
MP-1302-APL	\$199.00
RGB Card for Apple II or Franklin 100	
Zenith 12" Green	\$139.00
12" Amber	\$169.00
A MDEC-1 Colour 13"	\$398.00
MACKINTOSH	\$169.95
12" Amber	

## TTX™ 1014

RELIABLE DAISY WHEEL RO PRINTER



### \$749

#### 1014 FEATURES

- SERIAL AND PARALLEL INTERFACE
- WORD STAR\* COMPATIBLE
- QUIET OPERATION
- PROGRAMMABLE PITCH AND LINE SPACING
- COMPACT AND DURABLE
- MICRO, MINI, MAINFRAME COMPATIBLE
- INTEGRAL PIN FEED GUIDE (ADJUSTABLE)
- RIBBON CARTRIDGES AND PRINTWHEELS READILY AVAILABLE

Also Available The CP80 DOT MATRIX \$495. Same as Epson 80.

**Assembled  
\$58.00**

**ZX81  
Printer  
\$119.00**

**16K Sinclair Memory  
\$59.00**

#### Books Hardware

COMPLETE ZX81 BASIC COURSE - Inc. 2 tapes	39.95	ZX81 Ass. ZX Print	58.00
NOT ONLY 30 PROGRAMS: 1K MACHINE LANGUAGE MADE SIMPLE	18.95	54K RAM (Memotech)	119.00
ZX81 ROM DISASSEMBLY PART A & PART B	19.95	ORION 64K	199.00
UNDERSTANDING ZX81 ROM	24.95	32K RAM (Memotech)	149.00
T/S 1000: PROGRAMS, GAMES and GRAPHICS	19.95	16K RAM (Sinclair)	119.00
LEARNING T/S BASIC	22.95	500MA	59.00
THE BASIC HANDBOOK	29.95	Power Supply (650 M.A.)	9.95
49 EXPLODING GAMES	16.95	no soldering req.	14.95
COMPUTER FOR KITS SINCLAIR EDITION	8.95	Metal Case for above	19.95
MASTERING MACHINE CODE ON YOUR ZX81	24.95	Memopak Centronics Type Parallel Printer	29.95
T/S 1000 USERS GUIDE (Vol 1)	16.95	Interface	119.00
EXPLORERS GUIDE TO THE ZX81	16.95	Memopak ZX81 Keyboard	129.00
ZX81 POCKET BOOK	16.95	Memo Calc	79.95
GETAWAY GUIDE	16.95		
GETTING ACQUAINTED WITH YOUR ZX81	16.95		

**Additional Hardware & Software  
for the SINCLAIR ZX81  
AVAILABLE ON REQUEST.**



**THE ORION II 64K COLOUR COMPUTER \$495.00**

64K with dual Basic, Apple Soft & Integer Basic  
ORION II

Fully assembled 100% soft & hardware Apple™II plus compatible computer (AMB-1 + keyboard + Case + power supply and speaker, regular basic & integer basic . . . . . \$495.00

**ORION III**

Same as Orion II, plus upper and lower case with numeric keypad with multi function keys . . . . \$595.00

Same 64K computer with 1 drive, 1 controller and 12" green monitor

Orion II \$995.00  
Orion III \$1,095.00

**INTRODUCING THE VZ200 \$165.00**

**A Personal computer thats full featured, simple, universal and AFTER AFFORDABLE!**

**Full Featured**

- 9 Colours
- Full size, moving-key keyboard
- 45 Automatic repeat keys



- 16 Pre-defined single character graphic keys
- Low and high resolution graphic modes

Introductory Special 16K RAM \$89.00  
Reg. \$99.00

- Sound output
- Full on screen editing
- Fast Z80/A CPU
- 12K ROM, 4K RAM expandable to 64K
- Built in RF output to TV and Video o/p to monitor
- Complete with AC adapter, Demo program, all cables required, TV/Transformer, switch and 8 manuals
- Light and portable — easily fits in briefcase

**Peripherals Are Reasonably Priced. You Can Afford To Grow With The VZ200**

**CALL FOR MORE DETAILS****WOWIE! LOOK AT THIS!****6502 BOARDS & ACCESSORIES**

<b>AMB-1</b>	<b>\$325.00</b>
Mother Board, APPLE II Compatible, Assembled & Tested c/w Basic ROMs, 64K RAM, Made in Japan, Integer & Reg Basic.	
<b>ABB-1</b>	<b>\$ 39.00</b>
APPLE II Compatible, Motherboard (no components)	
<b>6502 Board Kit</b>	<b>\$250.00</b>
Includes all parts	
<b>AEB-1</b>	<b>\$119.00</b>
EPROM Burner Card	
<b>AIC-1</b>	<b>\$89.00</b>
Integer Card	
<b>AEC-1</b>	<b>\$89.00</b>
80 Column Card	
<b>AZC-1</b>	<b>\$89.00</b>
Z80A (CPM) Card	
<b>APC-1</b>	<b>\$89.00</b>
Parallel Printer Card	
<b>ASC-1</b>	<b>\$89.00</b>
Serial Printer Card	

<b>ALC-1</b>	<b>\$79.00</b>
16K RAM (Language) Card	
<b>AKB-2</b>	<b>\$109.95</b>
Keyboard; Numeric key pad with function keys, replacement for APPLE II	
<b>AC-2</b>	<b>\$99.00</b>
Beige APPLE II Case (for above keyboard)	
Case & Keyboard numeric	<b>\$190.00</b>
<b>APS-2</b>	<b>\$ 99.00</b>
Switching Power Supply for APPLE II; +5V @ 5 amps, +12V @ 3 amps, -5V @ 1/2 amp, -12V @ 1/2 amp; c/w on-off switch & connecting wires	
<b>AAA-2</b>	
Disc Drive, 5 1/4", APPLE II Compatible, Excluding Controller Card	<b>\$299.00</b>
with controller	<b>\$379.00</b>
<b>ADC-1</b>	<b>\$75.00</b>
Disc Drive Controller Card for two drives; Apple II Compatible	
APPLE II is a registered trade mark of Apple Computer Inc.	

**Orion Electronic Supplies Inc.**

40 Lancaster Street West  
Kitchener, Ontario N2H 4S9  
(519) 576-9902

Master Charge & Visa, COD, Cheque, Money Orders accepted. COD's, shipping & insurance extra. Write for our FREE FLYER.

Prices subject to change without notice.

Circle No. 6 on Reader Service Card.



# Electronic Mail

**Is the postman hanging up his  
bicycle clips for the last time?  
We'll let you decide.**

**By Roger Allan**

THE DEVELOPMENT OF new technologies for high-speed transmission is a logical extension of the growth of data processing evident over the last 20 or 25 years. Without the necessary data transmission links, economies associated with large scale processing of data would generally not be available to relatively small branch offices of large corporations and governments. The linking of even quite large regional branches to centralized data banks or the access by small outposts to powerful programming is made more attractive by the development of improved transmission quality and volume capability by common carrier networks.

It would be expected that expansion of computer based electronic mail would closely follow, upon the establishment of easy to use decentralized processing and access systems. Mail and message functions should almost be a by-product of the new technologies. While the initial impetus is to link dispersed branches of large corporations, once the necessary transmission facilities, networking and software are in place for these purposes, then the means for links between more disparate organizations would also be *in situ*.

It has been depicted that the development of electronic mail should chronologically fall into three main evolutionary stages:

- characterized by the communication, primarily inter-company, of like machines: fax-to-fax, communicating-typewriter-to-communicating-typewriter, Telex-to-Telex, *et al*;

- characterized by the capability of totally different kinds of equipment to "talk" to each other;

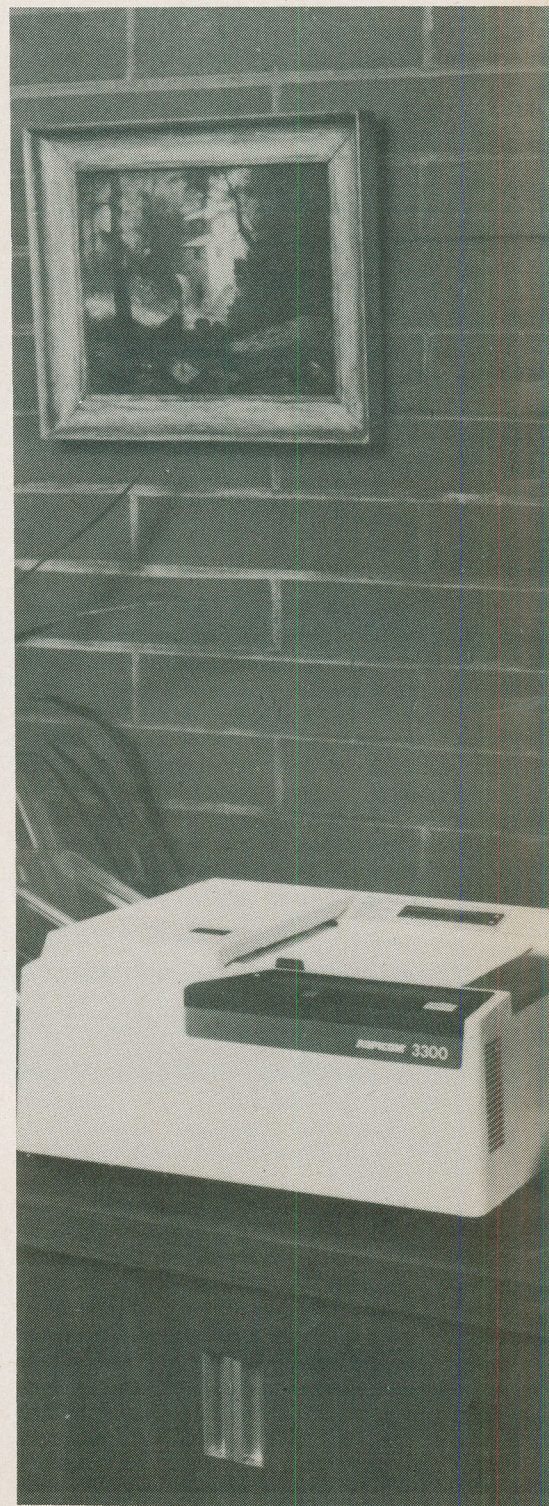
- characterized by satellite and fibre optic links (see "Fibre Optics", ETI, June 1982) established reducing line costs.

Interfaced equipment for a variety of communications and processing functions will have proliferated. This final stage would also be marked by serious competition for control and direction of electronic mail, and for control interfaces between equipment to see that the entire system is used efficiently and economically as possible, usually to the financial benefit of the government of the day.

However, the provision of software for linking the many types of presently incompatible electronic office equipment both within and between businesses may prove to be a considerable obstacle to the adoption of integrated electronic mail systems. An internationally accepted protocol for communicating word processors, called Teletex, has been devised. Meanwhile, attempts are being made to develop the first formal representation encompassing all types of electronics message systems (EMS). Besides the problem of a common language, the development costs required to integrate individual office systems already established into a general electronic mail network will tend to constrain the rate of development of a general system.

Another problem for users of electronic communications systems is the perceived lack of security of information transfer. To a large extent, this can be overcome by encryption of messages, although probably no encryption technique is impossible to break and it could make the encryption of messages too expensive. Until potential users come to accept this aspect of electronic mail, physical delivery will continue to have an important advantage in this respect.

As such, the development of electronic mail will be related to the extent to which the current mail system meets user requirements. Complaints made by postal





The major impact of electronic mail will be on business communications. The facsimile unit shown is a Canadian unit from Rapicom, Ottawa.



users in Canada, the U.S. and Australia indicate a significant level of dissatisfaction, particularly among business users, with the adequacy of services, specifically by the criteria of timeliness of delivery.

### Knocking the Postie

*Prima facie* evidence of dissatisfaction with the speed and/or reliability of the postal system for some business needs is the growth of courier services. Although courier services have been in existence since the early 1930s, growth in the industry has been especially strong over the last decade. Similarly, the growth of document exchange centres providing reliable and speedy services for specialized business needs is a further example of document transmission outside the national postal systems. The "pressure" created by commercial users for reliable alternatives to the postal system is probably directly related to the existing standard of service. One writer has indicated that both British and West German authorities are less optimistic about the success of an electronic mail system than commercial systems producers because of the high standard of the present system. The Postfax system in Britain, for instance, is not thought to be widely used because next day delivery is virtually assured for domestic users.

There is, however, little doubt that the major initial impact of electronic mail systems will be on intra- and inter-business communications. Significant inroads can be expected in government related mail and in mail received by households from business and government under future electronic mail systems. The initial diversion of mail away from the postal system is likely to be in areas which provide, at present, a significant proportion of the cross-subsidy for services to remote areas and registered publications. This will probably place a higher burden on those users not able to divert mail electronically, specifically the householder.

Further, in the long-term, courier services are likely to face significant competition from electronic systems. In a widely quoted dramatic example, 90% of one major U.S. courier service's income in 1969 was from cancelled cheque deliveries. After the introduction of the Federal Reserve electronic funds transfer system, this proportion had dropped to 42% by 1975. While this example does not specifically involve electronic mail, similar such occurrences are expected. Courier services may benefit in the short term, however, from some services, such as facsimile, where one "leg" of transmission may require rapid physical delivery from a receiving terminal or to a sending terminal.

From the point of view of the national postal services, a critical aspect is

the extent to which developments in electronic mail techniques and facilities will generate additional communications as opposed to diverting communications from the customary mail system. It is felt that in the early stages such techniques can be expected to increase the number of communications, but that in the long run there will be a substantial and permanent diversion of communications away from the traditional or customary methods.

### Basic Types

There are essentially two generic types of electronic mail systems: facsimile and "pure" electronic.

The facsimile process is an outgrowth of British Telecom's "Bureaufax" system inaugurated in 1980 which provided high-speed facsimile transmission to and from a large number of overseas countries (59 in 1982). It was primarily designed for business users. In the same year, it very rapidly resulted in the establishment of INTELPOST, involving the satellite transmission of facsimile documents (via Canada INTELSAT) between London and Toronto for both business and non-business users. This system has now been expanded to provide high-speed electronic mail links between 100 towns and cities in Britain, some dozen cities in Canada (with more coming on stream each month, and some cities having a number of pick up and delivery stations) and relatively similar numbers of stations in the Netherlands, the United States, Australia, Germany, Argentina and Switzerland. More countries are expected to join shortly.

As explained by John Hovey, Service Manager at Rapicom's Ottawa office, the manufacturer of the equipment used by Canada Post (Rapicom 3300 Desk Top Digital Facsimile Transceiver and the Rapicom 6300 Digital Facsimile Transceiver), the process of transmission is quite straightforward. The Sheet containing the communication is inserted into a device which looks like a photocopier. There it is configured by being scanned by a charge coupled device (CCD), the information is processed, compressed, passed through a modem and transmitted at high frequency in digitized form over ground lines. For transmission within Canada, the connection between stations is strictly by telephone line, though for overseas transmission the INTELSAT satellite system is used. When the communication is received at the other end, it is formatted, printed *a la* photocopier, put in an envelope and consigned to the customary post office dissemination process. The transmission rate is 9600 bits/second.

According to David Weinberg, Manager of Canada Post's Electronic Messaging Service in Ottawa, the cost is \$5 for two pages, regardless of where in the world the message is to be sent. Upon



# WE'RE HERE AT LAST! NOW OPEN DIRECTLY TO THE PUBLIC

## C & H ELECTRONICS PLUS

● MAIL ORDER DEPARTMENT ●

Call 9 to 5 Mon. to Fri. - 10 to 2 p.m. Sat.

**NOT ONLY DO WE HAVE MORE TO OFFER, BEING A NATIONAL WHOLESALE ACROSS CANADA, ALL OUR PRODUCTS HAVE A FULL 180 DAYS WARRANTY (UNLESS STATED OTHERWISE). WE CARRY ONLY THE BEST QUALITY MERCHANDISE AT THE LOWEST PRICES AROUND. ► PLUS FREE DELIVERY ANYWHERE IN CANADA! (NO MORE PARKING HEADACHES OR FRUSTRATING LINE UPS) ON ORDERS OF \$300.00 OR MORE.**

**NO FANCY OR EXPENSIVE DISPLAYS - JUST GOOD PRICES & EXCELLENT SERVICE**

### COMPUTERS

#### SOURCE 9000

\*Well built 48K compatible (to you know what!), numeric keypad, ABS Case, heavy duty power supply, 8 expansion slots, U/L case ..... **\$595.00**  
(REG. \$699.00)

#### SOURCE 6400

\*The only hassle free-with APPLE-computer. Multi-System 64K memory board, 9 expansion slots and unrestricted memory. No ROM and fixable language. Therefore allowing user to create/operate any language with over 50 different expansion cards on the market.

\*Includes numeric keypad, heavy duty power supply, U/L case, 25 function keys, card to run APPLE™ and more!

\*No legal worries with APPLE on this one! ..... **\$795.00**  
(REG. \$849.00)

#### SOURCE 2000

\*The ultimate computer with both 6502 and Z-80 CPU's, 64K expandable to 294K, built in disc printer interface, 40/80 column selectable, U/L case, 25 function keys, numeric keypad, heavy duty switching power supply LED reminder on board and (2) volume controlled speakers..... **\$995.00**

(REG. \$1149.00)

\*Surfboard beware\*

#### Apple Ile "Starter System"

\*Includes 64K, 80 column card, drive/controller, Apple III monitor and stand..... **\$2495.00**  
(REG. \$2795.00)

### \*\* COMING SOON IBM CLONES \*\*

#### Source Cards

16K ..... **\$65.00**  
Z-80 ..... **\$65.00**  
80 column ..... **\$79.00**  
Disc Controller ..... **\$65.00**  
Freeze Play ..... **\$99.00**  
(Wildcard emulator/disk/documentations)  
192K Disk RAM ..... **\$499.00**  
(Virtual Disc Card with (2) software pkgs)  
Grappier/printer ..... **\$79.00**  
Soft switches ..... **\$29.00**  
(for 80 col. card)

#### Perisoft Cards

Messenger..... **\$119.00**  
(Dual/link RS232C, built in firmware, 1 year warranty)  
Timelink ..... **\$109.00**  
(Built-in firmware, alarm clock, 1 year warranty)

#### Wizard Cards

16K ..... **\$109.00**  
80 column ..... **\$229.00**  
IPI Printer ..... **\$95.00**  
16K Buffer card ..... **\$199.00**  
(Above all 2yr warranty)

### ACCESSORIES

Flip 'n File (Holds 50 diskettes) ..... **\$32.00**  
(Holds 50 diskettes)  
Hayes Joysticks ..... **\$59.00**  
Pride Joysticks (self centering) ..... **\$40.00**  
Apple Stands (Fits 2 drives/monitors) ..... **\$39.00**  
Printer Stands ..... **\$35.00**  
(5" high, paper feed slot)  
Muffin Fans (dual outlets) ..... **\$50.00**  
Siemens Fans ..... **\$95.00**  
(Surge suppression/filter/outlets)  
Paper ..... **\$39.00**  
(2100 sheets, 9 1/2 x 11 perforated)  
Printer Ribbons ..... **\$CALL**  
Ribbon Re-Inking (Saves on new ribbons) ..... **\$CALL**  
Plott II Graphics Table ..... **\$129.00**  
Light Pen/Interface/Sftwr ..... **\$369.00**  
Hayes Modems ..... **\$CALL**

### DISKETTES

Generics ..... **\$23.00**  
BASF ..... **\$29.00**  
Dysan ..... **\$33.00**

● All box in 10's & SS, DD

Send us any diskettes and a list of particular softwares you want & for \$10.00 ea. we will have it mailed to you. (Providing its on our list)  
**(\$25.00 CLUB REGISTRATION FEE)**

### PERIPHERALS

CUMANA "Rainbow I" Disc Drive ..... **\$319.00**  
\*Siemens drive, direct from U.K., (REG. \$339.00)  
If you thought Quentin was good try this drive!

CUMANA "Rainbow II" Disc Drive ..... **\$379.00**  
\*IBM, D.D. Drive, Siemens based.

Slimline Drives ..... **\$319.00**

Zenith green screen monitors ..... **\$129.00**

NOTE: Call for quotes on hard disc drives, amber monitors or whatever you can't find.

### PRINTERS

C-ITOH  
Prowriter I (Parallel) ..... **\$599.00**  
Prowriter II (Parallel) ..... **\$1009.00**  
Starwriter F-10 (40 cps letter quality) ..... **\$1775.00**  
F-10 Tractor option ..... **\$399.00**

OKI-DATA 160 cps Printers  
Microline 92 ..... **\$799.00**  
(U.S. hottest printer, prints 160 cps dot matrix, 40 cps letter quality)  
Microline 93 (15" Carriage) ..... **\$1599.00**  
Microline 82A ..... **\$669.00**  
Microline 83A (15" Carriage) ..... **\$999.00**  
Microline 84P (200 cps) ..... **\$1599.00**  
Microline 84S (200 cps) ..... **\$1659.00**

EPSON  
FX-100 ..... **\$979.00**  
FX-80 ..... **\$879.00**  
FX-80 FT ..... **\$699.00**  
NEC 8023A ..... **\$699.00**  
Toshiba P1350 ..... **\$2279.00**  
(Top of the line)

Introducing: The Riteman Printer  
\*Epson FX-80 emulator, 120 cps, 9x9 dot matrix, true 1:1 dot ratio, bi-directional, slimline..... **\$599.00**

SMITH CORONA ..... **SPECIAL \$579.00**  
TP-1, letter quality  
SMITH CORONA ..... **\$750.00**  
TP-2 New Model, letter quality

**\*IF YOU DON'T SEE IT! ASK!\***

**C & H ELECTRONICS PLUS**

**MAIL ORDERS:** Send certified cheque/money order. Ontario residents must add 7% PST Visa card accepted: card no., name, signature, exp. date and bank name please!

23 Passmore Ave., Unit 11, Scarborough, Ontario. M1V 2J8.  
(Just (1) light North of Finch right side of Kennedy Rd.)  
(416)292-0813 — TELEX 065-25320 C&H TOR

**ATTENTION:** Clubs, schools, and co-op purchasers call for our special pricing catalogues.

Dealer Inquires welcomed!  
Contact: Rob Laver

**VISA**

Circle No. 26 on Reader Service Card.





receipt, the envelope can be sent through the regular mails at no additional cost, or sent special delivery (\$1.06 extra in Canada, \$5 in Germany, for instance). Further, the recipient can be telephoned upon receipt of the message, and can stop at the post office and pick it up. Theoretically, a message can be sent from Toronto to, say, Calgary and picked up at that end a mere few minutes after its receipt. It is supposed to be very good for typewritten matter and drawings, though it does not have the capability of colour.

### Way of the Future?

According to Weinberg, "handwritten mail is on the way out," and electronic mail "is the way of the future. Unless Canada Post jumped into electronic mail, we would be left behind." Today, INTELPOST has not been pushed by Canada Post, but there is a large publicity campaign planned for the fall and spring of 83/84. Details as to the volume generated over the past three years was not available, though a spokesperson for Canada Post has said, "it's not much."

The two countries which have heavily invested in electronic mail via the national postal system (as opposed to private carriers or the adjuncts to various telephone companies) are Britain and the United States.

In Britain, the system is known as Telecom Gold, in which a laser beam optically reads the printed document and then transmits it to any one of several thousand electronic mail boxes, or vice versa. Further, the system links into inter-

national services so that documents can be transmitted to micro-computer users worldwide. Should the recipient not have a microcomputer, the mail is sent from the nearest receiving station by traditional methods for the last leg of its transmission journey.

It is, however, the U.S. Post Office's E-COM system which seems to be the current state of the art in this area.

As explained by E.M. Alexander of the RCA Corporation which provided the equipment for E-COM to the USPO, "INTELPOST is not the bellwether for future electronic mail systems," though E-COM is. The difficulty lies in the quality of the finished product; INTELPOST, being a facsimile reproduction system, isn't really very good, while E-COM uses good quality dot-matrix printers (numbering from 3 to 9, depending on the receiving station of which there are currently 25) on good quality bond paper and provides a quality which is superior and far more business-like than INTELPOST's finished product. Further, facsimile transmission requires the company to either possess a piece of special equipment into which the document can be fed, or to physically take it to the nearest USPO which would have such a device (similarly in Canada). With E-COM, on only needs a modem, and a member of staff who has received a few hours training and a practice session.

RCA first became interested in the subject and commenced research on how to do it some seven years before the USPO awarded them a \$38.1 million dollar contract to provide the hardware, a training

station and set-up help. The system developed is dependent on land lines using common carriers, due to FCC regulations. It is TTY synchronous, operating at 300 or 1200 baud rates, with 2400 baud (and up) rates available with additional equipment. When received by any one of the 25 offices currently available in the U.S., the computer, on-line twenty-four hours a day, automatically tapes the message at the front end by a dumb processor. The message is then automatically transmitted to the nearest available station to the recipient, where it is re-processed, electronically sorted, the message typed out (on 80-character lines at 600 lines per minute), automatically sorted, placed in the envelope which is typed, and sent either through the regular mail system or by special delivery. The *modus operandi* of the computer transmission follows the ASCII guidelines, specifically an eight bit, alphanumeric system providing upper and lower case. As such, a message, in a distinct envelope, can be received anywhere in the contiguous United States within two days.

The E-COM system will accept messages in three different formats:

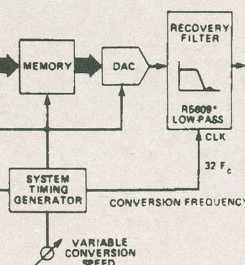
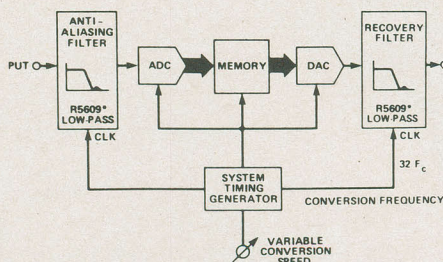
- Single Address Messages (SAM) which are those in which a unique text accompanies each address;
- Common Text Messages (COT) which are those in which a common text is accompanied by a list of addresses (eg. for bulk mailings);
- Text Insertion Message (TIM) which are those in which a common text is accompanied by both a list of addresses and



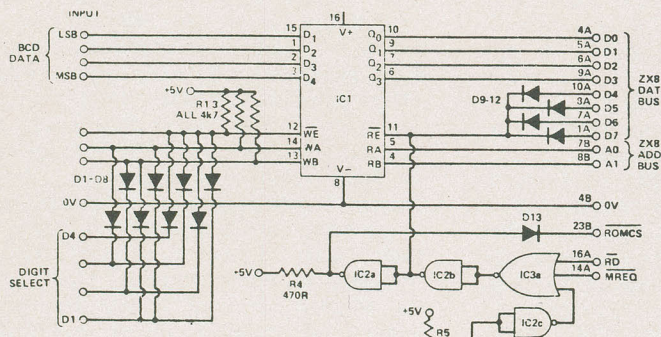
Moderately good quality typewriter ribbon. And a film type ribbon.

Moderately good quality typewriter ribbon. And a film type ribbon.

(a)



(b)



(c)

Examples of the reproduction quality of the electronic mail service. A good quality typewriter (a) produced the best copy, along with original line drawings (b). Photocopies (c) were somewhat fuzzy, and original photographs were not usable at all.

a unique text to be inserted in each printed message.

To date, the use of this system is running at about 1 million messages a month.

### Small Business Users

At a cost of 31¢ (US) per page, and an additional 9¢ for subsequent pages, the price is comparable with regular mailing services. There are, however, two problems with the system. One is that a sender must send a minimum of 200 items per transmission, though this may be one item to 200 addresses. For small businesses this can be a problem, though there are intermediary companies which stand between the USPO and the user who will collect messages in less than 200 and "batch lot" them for an additional fee. Secondly, very small businesses who have not as yet purchased or leased a microcomputer for the initial composition of the message must likewise use an intermediary organization for an additional fee.

Without a great deal of publicity, and recognizing that there are a few wrinkles in the system to be worked out or adjusted, such as permitting smaller batch lots to bring more small businesses into using it, the provision for a business reply or courtesy card reply, *et al*, the system has nonetheless grown quickly. Further, according to Alexander, the USPO has "not received so much as a single complaint from a user." The expected volume of transmissions for this system is 1.1 billion pieces per year by 1986.

And as for the postman about to hang up his bicycle clips? Well, there will always be little towns and hamlets left to service.

INTELPOST permitted ETI to partake in a demonstration of the facsimile electronic mail system. The art department kindly made up a specimen melange of bits and pieces, which this author then physically took down to the Canada Post Office on Front Street, Toronto. First problem was that the pictures and diagrams were mounted on thin card. This didn't fit the machine, so with the help of a staffer and a pair of scissors we transferred the items to a piece of paper. The paper didn't fit the machine, being too wide. Further use of scissors. Finally it worked.

The item was transmitted at 10:30 Toronto time on a Friday, and was collected from the mail box by Our Man In Calgary, Mr. B.J. McLauren, at five-thirty the same day. He immediately consigned it to the mails to be returned to us; it arrived on Monday morning.

ETI

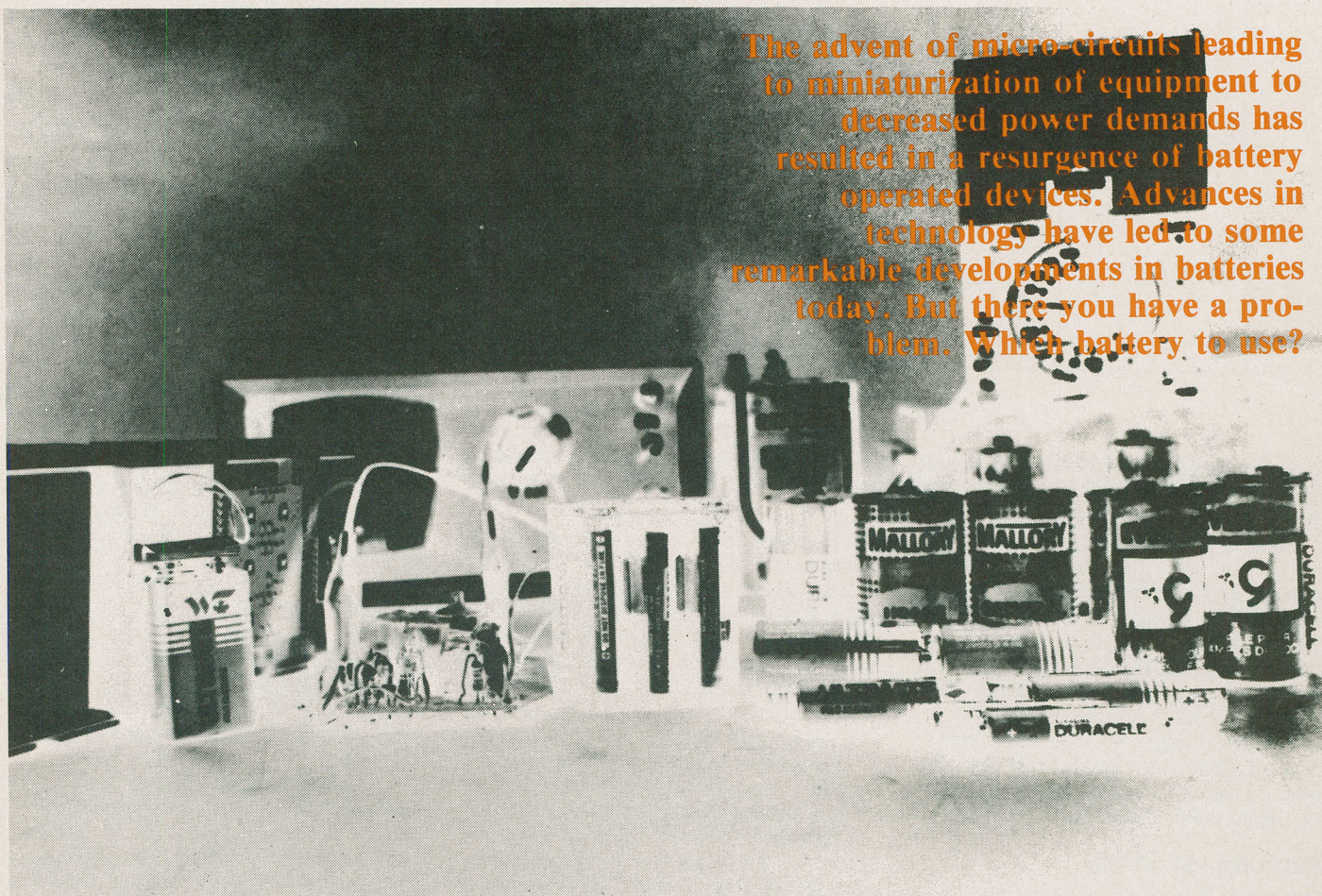
help  
your  
Heart Fund  
help your  
heart





# Which Battery To Use?

The advent of micro-circuits leading to miniaturization of equipment to decreased power demands has resulted in a resurgence of battery operated devices. Advances in technology have led to some remarkable developments in batteries today. But there you have a problem. Which battery to use?



MANY PEOPLE HAVE a tendency to replace conventional 'dry' cells with the rechargeable nickel-cadmium type simply to avoid replacement costs, but this practice may not be cost effective and can even lead to reduced equipment performance and greater cost. In order to make some form of meaningful comparison between types, it was necessary to select one common size of cell and look at the performance under similar load conditions. Also, because the performance of carbon-zinc cells is more dependent on usage than alkaline or NiCad cells, a definite statement as to which is best, cannot readily be made.

The purpose of this article is to try to present a guide to the selection of cell type best suited for an application, bearing in mind equipment performance, duty cycle, current demand, weight and cost. The information presented here has been obtained from the data sheets of many manufac-

turers and should not be regarded as typical of any particular make. Because of the variation in performance of carbon-zinc cells with differing loads, the presentation has been optimized to give a reasonable overall guide to performance without being too optimistic.

## Cells Tested

The basic cells compared are the nickel-cadmium rechargeable type, the ordinary carbon-zinc dry cell, both normal and heavy duty (leclanche type), and the manganese dioxide-alkaline type. The size of the cells selected for comparison are the 'AA' or UM-3, SAA designation R6. In the case of the NiCad, this is a 450 mA hour capacity cell. The load characteristic selected was a current drain of 30 mA for four hours per day. This is typical of much portable equipment such as walkie-talkies, portable radios, calculators, etc. This was also the load which was easiest to

compare on a range of data for various cells.

## Result of Comparisons

Generally, the comparison here shows alkaline cells to have a performance about twice that of ordinary carbon-zinc cells; however, they can be many times better, depending on usage. Alkaline cells have higher efficiency when used for continuous or heavy load (high current) applications where the conventional carbon-zinc cell is less effective. The rechargeable NiCad is good for heavy current applications, provided the correct supply voltage can be achieved. Unfortunately, carbon-zinc and alkaline cells are not directly interchangeable with NiCad cells due to differing terminal voltages. This is caused by the different types of materials and construction used for these cells. The result is that while carbon-zinc and alkaline cells have a terminal voltage of 1.5 V, the NiCad cell has a voltage of only 1.2 V.



## Which Battery to Use

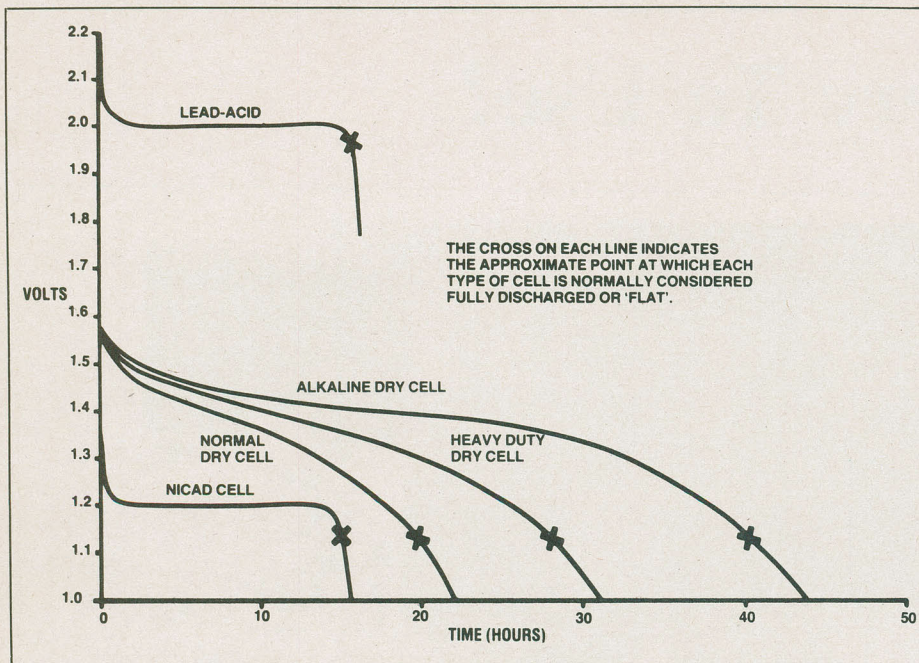


Fig. 1. The discharge performance of various cells. The discharge characteristics of a lead-acid cell are shown for comparison. Note that terminal voltage cannot be used to indicate the state of charge of NiCad cells.

Figure 1 shows the performance of the various cells and that of a similar capacity lead-acid cell for comparison. It is important to note that the terminal voltage cannot be used to indicate the state of charge of the NiCad cell, but can be used as an approximate indicator for 'dry' cells. NiCad cells are about 25% to 30% heavier than 'dry' cells and because more of them may be required for the same voltage, this could mean a substantial weight penalty in portable equipment.

### Batteries At Work

The place where these various cells must work is in the equipment, and this is where many factors become important. The points to be considered are: *duty cycle* — is the load to be continuous or intermittent high current, or is it to be low current, continuous or intermittent? *Operating environment* — will the power be required at extremes of temperature? What is the design voltage of the equipment and can sufficient cells be accommodated to provide this? *Replacement or recharging* — in a particular situation one option may be preferable to the other, and which option is cost effective? *Operational life* — how long will the selected cell operate before recharge or replacement is necessary? *Shelf or storage life* — how good is a particular cell after a period of no use?

#### Duty Cycle

This will have a major effect on the performance of cell in any situation. Conventional carbon-zinc cells perform best at a relatively light load when operated in-

termittently. This allows a degree of recovery between periods of use. The service life of alkaline cells is relatively constant regardless of whether use is continuous or intermittent. This type of cell then shows its advantage mainly when continuous use is required. It can have a service life of three to ten times that of carbon-zinc cells in ideal circumstances.

Another advantage of the alkaline cell is its ability to supply considerably higher currents than the carbon-zinc type. In fact, the current available from alkaline cells can approach that from NiCad rechargeable cells in some circumstances. For high current loads, intermittent or continuous, the NiCad cell may be preferred, either because other cell types cannot supply the required current or because discharge is so rapid that continual replacement would be necessary. Substitution of carbon-zinc or alkaline cells with NiCads should only be undertaken after consideration of all the factors involved, including operating environment, equipment voltage requirements and storage life.

#### Operating Environment

Carbon-zinc cells deteriorate quickly at temperatures above about 50°C and become rapidly unable to deliver useful current below -18°C. Alkaline cells show better operating characteristics at extremes of temperature. Although it is difficult to determine the upper temperature limit of these cells, it is considerably better than carbon-zinc cells. Alkaline cells perform reasonably well down to temperatures of -40°C.

NiCad rechargeable cells have an operating temperature range of about -20°C to +45°C but should not be exposed to temperatures below 0°C while charging. Generally, their operating temperatures are about the same as for carbon-zinc cells. There may be some temperature rise in NiCad cells during charging or heavy discharge, and this factor should be considered if these cells are used as a replacement for 'dry' cells in sensitive or critical equipment.

### Design Voltage of Equipment

This is an important factor when consideration is being given to replacing carbon-zinc or alkaline cells with rechargeable NiCad types or replacing NiCads with 'dry' cells. In equipment such as portable transceivers, satisfactory operation depends greatly on the available supply voltage. Some of this equipment is designed to operate from NiCad cells while the other is intended to use 'dry' cells. Most such equipment has a specified operating range of voltages and attempted use outside of this range will result in severely degraded performance, no operation at all, or possible damage to the equipment. Typical ranges for nominal 12 V equipment are 11 V to 14 V or 10 V to 15 V. There is a temptation to replace carbon-zinc or alkaline cells with an equal number of rechargeable NiCad cells but because of the difference in terminal voltage (1.5 V as compared to 1.2 V) a fully charged NiCad battery may not meet the minimum voltage requirements of equipment.

Figure 2 shows the performance of various battery types in a piece of 12 V rated equipment such as a portable transceiver. Note that if provision is only made for eight cells, then replacement with lower voltage types can result in insufficient supply for the correct operation of the equipment. Often the mere fact that the equipment operates at all under these conditions is more a tribute to the designer than the performance of the power source! On the other hand, replacement of NiCad cells with 'dry' cells could allow the equipment voltage specification to be exceeded.

### Replacement or Recharging

Which is best here will depend very much on the user requirement. For example, a transceiver used by emergency services might be more quickly restored to service by replacement of batteries than by recharging. For personal use, where failure due to battery discharge is not so critical, recharging may be acceptable. If the equipment is in heavy or continuous use, then recharging may be a viable alternative to replacement.

The cost of any option will depend on how often replacement is required, the







## Which Battery to Use

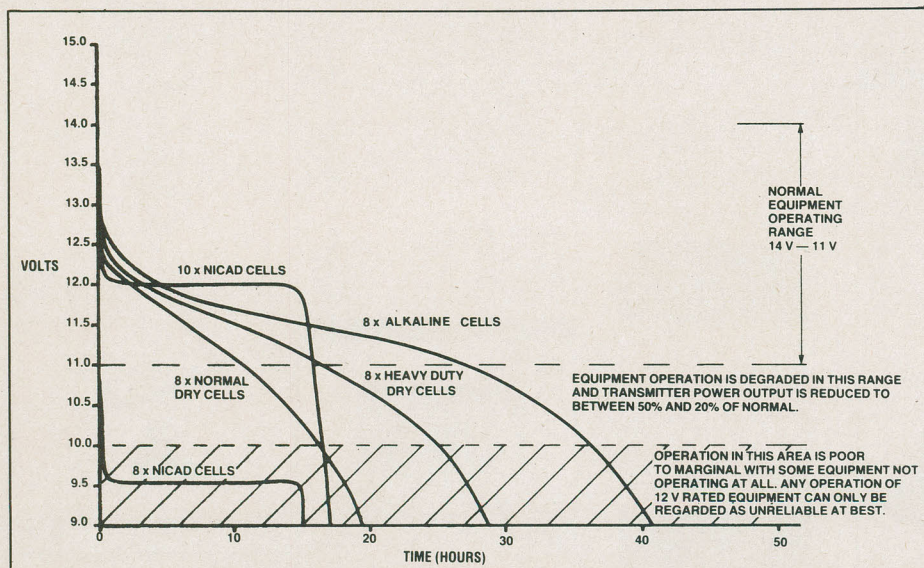


Fig. 2. The performance of various battery types in a 12 V operated handheld transceiver. Note that you cannot expect to replace eight dry cells with eight NiCads.

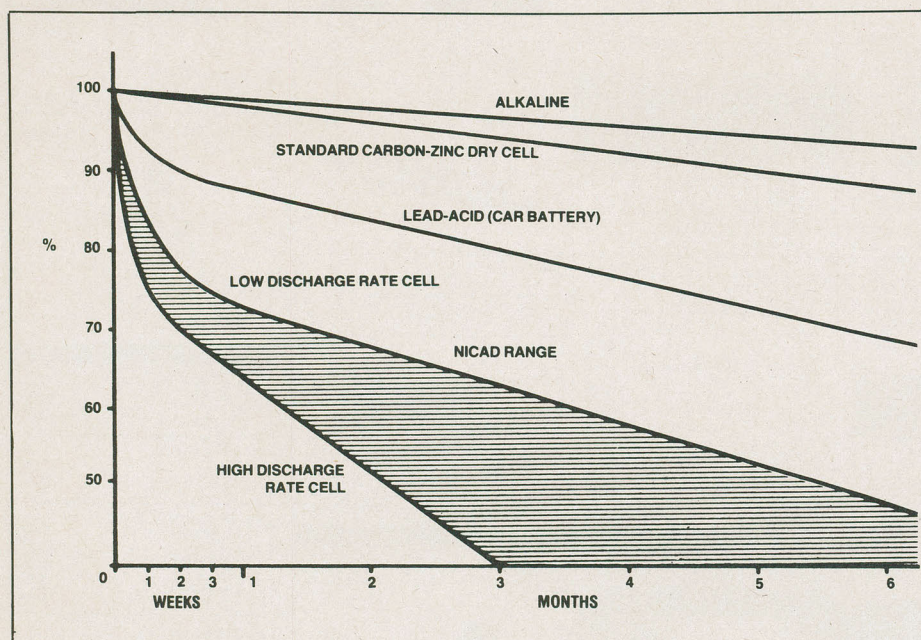


Fig. 3. All secondary cells self-discharge, which gives them a certain 'shelf life'. Here, the self-discharge characteristics of the various cells are shown. A lead-acid cell is included for comparison.

higher initial cost of rechargeable cells, (and you may need more of them), the cost of a charger and the cost of an additional battery pack if operation is needed while recharging is in progress. Another important factor, especially in an emergency environment, is the availability of power for recharging. If such a source is not readily accessible, a user may be ill-advised to use rechargeable batteries at all.

### Operational Life

The effective operational life of a battery may become very important if access to

replacement or recharged cells is difficult. As can be seen from Figure 2, the NiCad cells under this load will supply power for about 15 hours of operation. This is conditional on the battery being fully charged and in good condition. Ordinary carbon-zinc cells will provide about the same service life and heavy duty ones about twice this. Alkaline cells can be expected to have a greater operating life, about three times or better, than either NiCads or carbon-zinc as compared here.

There is a further factor which should be considered where the use of NiCad cells is contemplated. It has

become recognized that NiCad cells tend to develop a 'memory' of their usage pattern. What appears to happen is that if a cell is used to, say, only 50% of capacity and then recharged, after a few cycles of this pattern, the cell then becomes only capable of delivering 50% of rated capacity before going 'flat'. This condition can be reversed by correctly cycling the cell through several discharge and charge cycles, but unless this condition is recognized as developing, it may seriously degrade the operational life of the equipment in which it is used.

### Shelf Life or Self Discharge

All cells will discharge by themselves when not in use, to a greater or lesser degree. This self discharge will determine the length of time for which a cell can be left unused and still be able to deliver a reasonable proportion of its original charge. The major factors which influence the rate of self discharge are storage temperature, amount of charge at storage, and the condition of the cell.

The definition of shelf life is somewhat variable, but for carbon-zinc and alkaline cells appears to be the time taken to decrease to 90% of initial capacity. Accepting this definition then, gives the following approximate storage life-times for cells in good condition.

Carbon-zinc cell . . . . . 8 to 9 months

Alkaline cell . . . . . Over 2 years

NiCad cell . . . . . 3 days to 4 weeks

These storage times are based on a constant temperature of about 20°C to 25°C. Storage life may be improved by storing the cells at 5-10°C. Generally, higher temperatures cause more rapid degradation. Storage life is also shown in graphical form in Figure 3. An approximation for a lead-acid car battery type cell is shown for comparison. NiCad cells appear to show up poorly in this regard and some manufacturers now claim to have substantially improved this characteristic. The self discharge of NiCad cells depends on the type of cell, whether it is intended for high or normal current discharge. The condition of the cell is also important, whether it has been cycled correctly, the age (number of cycles), the environment in which it has been used and the state of charge at storage.

Consideration of the information provided here may be able to assist you to make a better informed decision as to the best power source for your battery operated equipment. It is not practical to cover all the eventualities and applications in a short article, but at least this should provide some guide to the cost effectiveness and practicability of the battery that you select. Most manufacturers will provide design and engineering data on request should you need to make a more detailed analysis of your particular needs. **ETI**



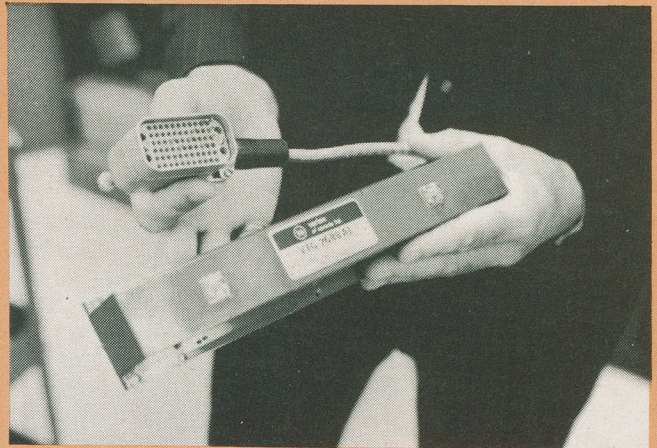
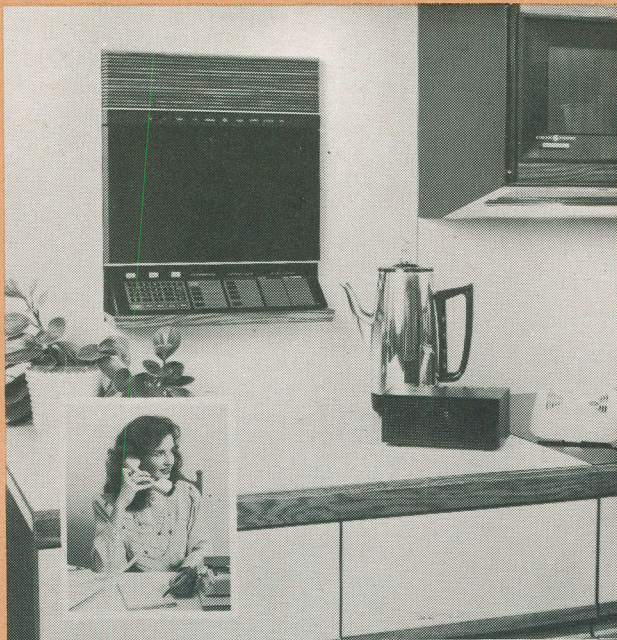
# ETI

# next month

At the time of going to press, the articles mentioned are in an advanced stage of preparation. However, circumstances may result in changes to the final contents of the magazine.

## Micros in Appliances

With 1984 approaching, you'd expect your appliances to be listening in to your every word. Eric McMillan looks at the current state of the art and proves that you have nothing to worry about ... yet.



## Travelling Wave Tube Amplifiers

Roger Allan continues his high-tech inquisition with a look at Travelling Wave Tube Amplifiers. Find out why travelling wave tubes need to be amplified.

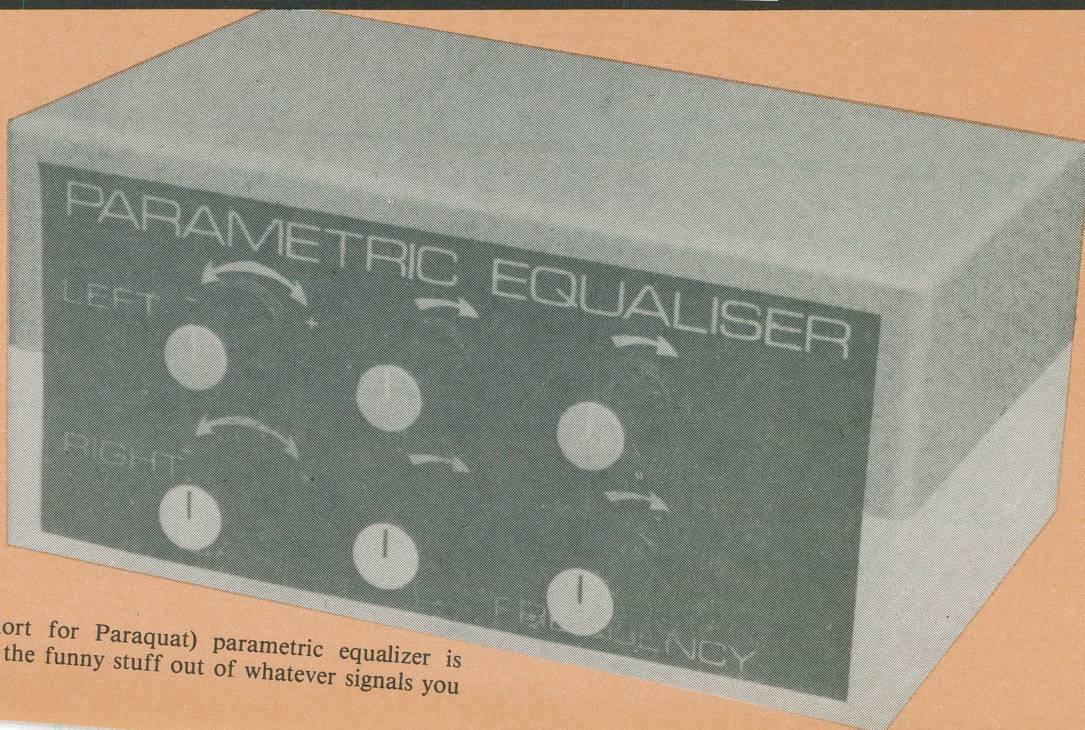
## PLUS!

**Accurate Risetime Measurements!**

**Hearing Aid Induction Loops!**

**Pop Amps!**

**LM396 10 Amp Regulator!**



## Para-Q

The Para-Q (short for Paraquat) parametric equalizer is designed to take the funny stuff out of whatever signals you put through it.



# NiCad Charger/Regenerator



To accompany our battery article, here is a NiCad charger which extends battery life by minimizing "memory" and metallic deposits.

by Mike Punnett

NICKEL-CADMIUM BATTERIES (NiCads) are becoming increasingly popular as replacements for conventional dry batteries in a wide range of equipment. Properly used, they can give an enormous cost saving over the life of the equipment, but if misused, tend to fail early.

Since NiCads have a tendency to self-discharge over a few months, they have to be charged regularly. Furthermore, to avoid the inconvenience of a flat battery, they are often "topped up" with charge even when far from discharged. This leads to an effect known as whiskering, where fine deposits of cadmium build up, which can partially short-circuit the cell, as well as reducing the active electrode size. This leads to a loss of capacity; a 500mAh cell may be reduced to 300mAh after a year of light service and frequent charges.

It has been found that "cycling" NiCads can return them to an almost-new condition. This process involves discharging the battery hard (at the 1 hour rate, e.g. 500mA for a 500mAh battery), until it reaches the minimum safe voltage — NiCads can be easily damaged by over-discharging. A full charge at the 10 hour rate follows. This rather rough treatment disintegrates the whiskers of cadmium,

and the full charge redeposits the metal on the electrodes. However, cycling NiCads "by hand" is a risky business, since they can easily be damaged.

The ETI NiCaddy was designed to cycle NiCads correctly and easily. It uses a minimum of components, and has two "programs": *cycle* and *charge*. Operating the unit is very straightforward: the NiCad is connected to it, and the appropriate button for the required program pressed. Cycle mode discharges the battery to its minimum safe voltage, and then switches to charge mode, in which the unit functions as a constant-current charger, automatically turning off when the battery reaches full charge. If the NiCad is already below its minimum safe voltage when connected up, the unit will automatically enter charge mode, overriding the switches, which are re-enabled when the battery rises above minimum safe voltage.

## Construction

Construction of the unit is quite straightforward, either on the PCB or stripboard. Sockets are recommended for the ICs particularly IC2 which is a CMOS device. Do not forget the three wire links on the PCB.

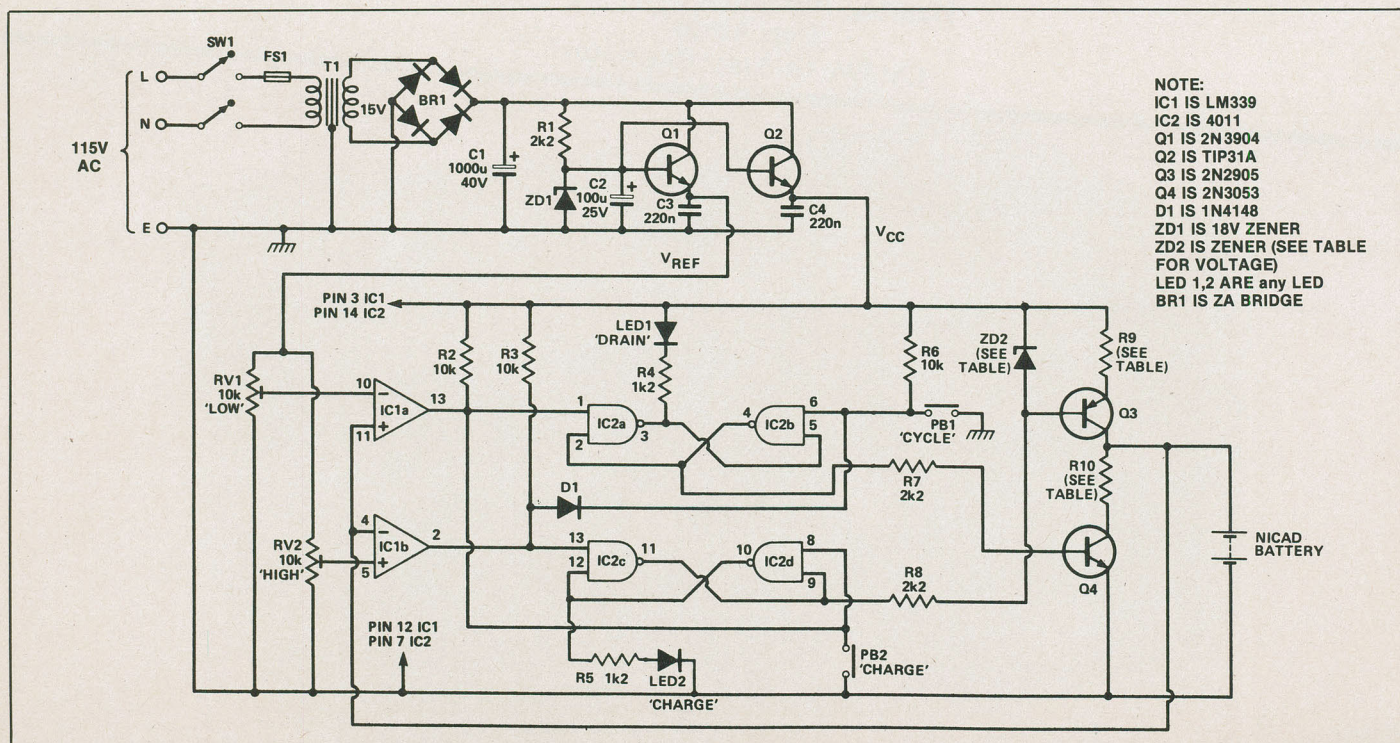




Table 1 gives component values for AA size (500mAh) cells (see later for details of use with other battery sizes). The circuit will work with batteries of up to eight cells. Remember that R11 will get hot, since the battery is discharged through this. For power ratings over 4 W, this component should be mounted off the board, preferably outside the box, to aid heat dissipation. Some of the transistors are fitted with heatsinks; Q1 has an aluminum heatsink (see overlay), Q3 and Q4 have push-fit TO5 heatsinks.

## Testing and Calibration

Check the voltages across C3 and C4. Both should be in the range 16.5-17.4 V. If not, the power supply section should be investigated. The precise values do not matter, since the calibration will allow for some variability.

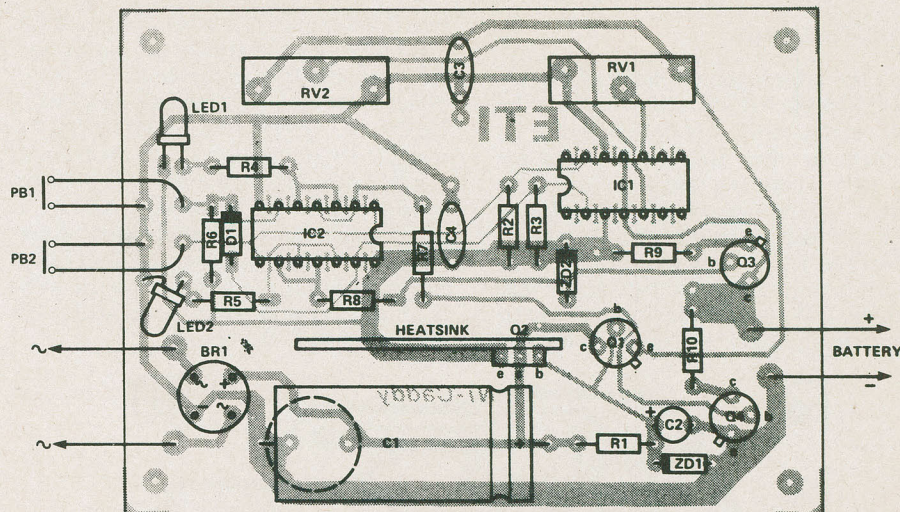
If the power supply is working properly, the unit can be calibrated. RV1 is set to the minimum safe voltage for the battery; this is 1.1 V per cell (i.e., 4.4 V for a four cell battery). An accurate, high resistance voltmeter connected to pin 8 of IC1 will enable the voltage to be checked. RV2 (full charge voltage) must be set rather more accurately, since the step in voltage which a NiCad exhibits as it reaches full charge is quite small. The best method is to set the voltage too high at first; about 1.7 V per cell on IC1 pin 11 is

adequate. The operation of the unit is then checked with a battery which is known to be in full working order; at this stage the circuit should perform as described above, except that it will not turn off after charging. The charging current can be checked; it should be 0.1 of the cell capacity (i.e., about 50mA for 500mAh (AA) batteries). The test battery is then left on charge for a long period — 20 hours if flat. This guarantees that it stabilizes at full charge voltage. Since the charging is constant-current, there is no

risk of damaging the battery by charging for too long. At this point, RV2 can be slowly turned down until the circuit just switches off, and the setting re-checked. The unit is now completed.

Table 1

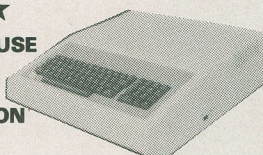
No of cells	D3 voltage V	R9 ohms/watts	R10 ohms/watts
2	10	210/1	4.7/2
4	8.2	160/0.5	10/4
6	5.1	100/0.5	13/7
8	3.6	68/0.25	18/10



# NO SALE TAX REQUIRED FOR ANY PURCHASE FROM ALBERTA — SO BUY FROM US AND SAVE \$

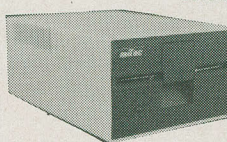
## ★ ★ 64K 6502 COMPUTER ★ ★

- COMPLETELY ASSEMBLED & TESTED - READY FOR USE
- 64K BYTE OF DYNAMIC RAM ON BOARD (W. BLANK EPROMS)
- KEYBOARD WITH UPPER AND LOWER CASE FUNCTION
- 4 x 4 NUMERIC KEY PAD INCLUDED
- DELUXE PLASTIC CASE
- 90 DAY WARRANTY



ONLY \$569

## 5 1/4" FULLHEIGHT, QUIET & PROVEN MITAC AD-1



DISK DRIVE  
SPECIAL.....\$325  
WITH CONTROLLER  
CARD .....\$380

90 DAY WARRANTY

## SPECIAL PACKAGE DEAL

### SP-1: 64K SYSTEM: \$1039

1. 64K COMPUTER (SAME AS ABOVE)
2. DISK DRIVE MITAC AD-1
3. DISK CONTROLLER CARD
4. 12" ZENITH GREEN MONITOR

### SP-2: 48K SYSTEM: \$989

1. 48K COMPUTER (DELUXE MODEL BELOW)
2. DISK DRIVE MITAC AD-1
3. DISK CONTROLLER CARD
4. 12" ZENITH GREEN MONITOR

RF MODULATOR W/SOUND, 10 FT CABLE AND TV-COMPUTER SWITCH BOX FOR APPLE (TM) AND ITS COMPATIBLE: \$20

## ★ ★ OUR BEST SELLING GOOD QUALITY BUT LOW PRICE 48K 6502 COMPUTER ★ ★

- COMPLETELY ASSEMBLED & TESTED
- 48K BYTE OF DYNAMIC RAM ON BOARD
- 12K BYTE ROM (3 BLANK EPROMS INCL.)
- KEYBOARD WITH UPPER & LOWER CASE FUNCTION
- 90 DAY WARRANTY

Christmas Special ONLY \$450

(HOUSED IN REGULAR ? LOOKALIKE CASE)

- OPTION: SAME AS ABOVE BUT HOUSED IN DELUXE PLASTIC CASE WITH ADDITIONAL 4x4 NUMERIC KEYPAD: \$515

### 6502 COMPONENTS

1. 48K A&T MOTHERBOARD (W. BLANK EPROMS) .....\$300
2. REGULAR KEYBOARD .....\$ 90
3. KEYBOARD W. 4x4 NUMERIC KEYPAD .....\$100
4. REGULAR ? LOOK ALIKE CASE .....\$ 80
5. DELUXE PLASTIC CASE .....\$105
6. SWITCHING POWER SUPPLY .....\$ 98

## INNOVATIVE ELECTRONICS & DEVICES

145 SITKA DR., FORT McMURRAY, ALTA. T9H 3C1  
Phone: (403) 791-4048 DAY, EVENING CALL 791-1164

## DEALERS INQUIRY WELCOME

A&T PERIPHERALS FOR YOUR APPLE(TM)

- DISK DRIVE CONTROLLER CARD .....\$60
- 16K RAM CARD .....\$59
- Z-80 CARD .....\$60
- 80 COLUMN CARD .....\$80
- PRINTER CARD .....\$80
- JOYSTICK (AUTO CENTERING).....\$30

### MAIL ORDERS

Send certified cheque or money order (allow 2 weeks for personal cheque). Mastercard and Visa welcome, please send card no., expiry date, and name of bank. Add 5% for shipping & handling. Any excess will be credited. Always include your name and address. \*No provincial sales tax required.

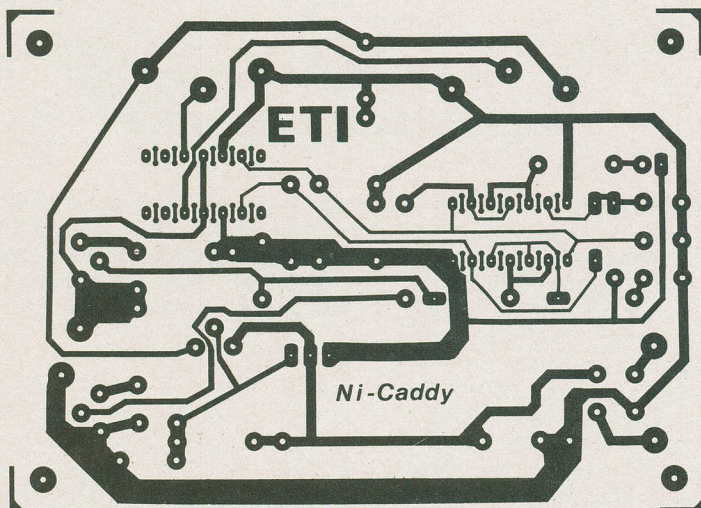




## Modifications

The circuit was originally designed for AA size (500mAh) NiCads, since these are the most widely used, but it can easily be adapted for other sizes by changing R9 and R10. These are calculated from the quoted values simply by reducing the resistance and increasing the wattage in proportion to the capacity; so for a 1 Ah six-cell battery, R9 would be 50R 1W and R10, 6R 15W. (The values do not have to be absolutely exact, of course). For cells

over 1 Ah capacity, it is best to uprate Q3 and Q4; since the circuit will be on for long periods, it is advisable to rate components generously, especially heatsinks. Replacing Q3/Q4 with TIP32/TIP31 respectively, mounted off the PCB on a suitable heatsink, will enable the unit to cope with cells up to about 4 Ah. As a rough guide, allow 1 Watt dissipation per Ah cell capacity when choosing heatsinks. Remember that the heatsink on Q1 may need uprating also. Allow a dissipation of 1.2 W per AH cell capacity.



## HOW IT WORKS

The power supply section is quite straightforward, using a very simple voltage regulator.  $V_{cc}$  is not critical, but the reference voltage,  $V_{ref}$ , must be stable, even though the precise voltage is not important. With a separate regulating transistor (Q1) the circuit shown is quite adequate. The two reference levels (the points at which discharge and charge respectively terminate) are derived by RV1 and RV2.

IC1 is a dual comparator which has a number of advantages over similar units, including single-rail operation, the ability to accept inputs at near-ground potential, very low offset, and open-collector outputs. In the circuit, the output of IC1a goes low to indicate that the battery has reached minimum voltage, and that of IC1b goes low when maximum voltage is reached.

IC2 is wired as two flip-flops, one for discharging (IC2a,b) and one for charging (IC2c,d). Pressing "Cycle" sets the discharge flip-flop and clears the charge flip-flop (via D2). When the battery reaches minimum voltage, or "Charge" is pressed, the discharge flip-flop is cleared and the charge flip-flop is set. The battery reaching full charge clears the charge flip-flop but does not set the discharge flip-flop. The status LEDs are driven directly by the two flip-flops, which also drive the output stage. The latter consists of a discharge circuit — when Q4 is turned on, the battery discharges through R11 — and a constant current circuit consisting of Q3 and its ancillary components, which is turned on by an active-low signal (when IC2 pin 11 is high, Q3 is driven fully off and passes no current).

## PARTS LIST

Resistors (all 1/4W 5% unless stated)

R1,7,8	2k2
R2,3,6	10k
R4,5	1k2
R9,10	See text
RV1,2	10k multi-turn preset pot

## Capacitors

C1	1000u 40V PCB mounting electrolytic
C2	100u 25V PCB mounting electrolytic
C3,4	220n polyester

## Semiconductors

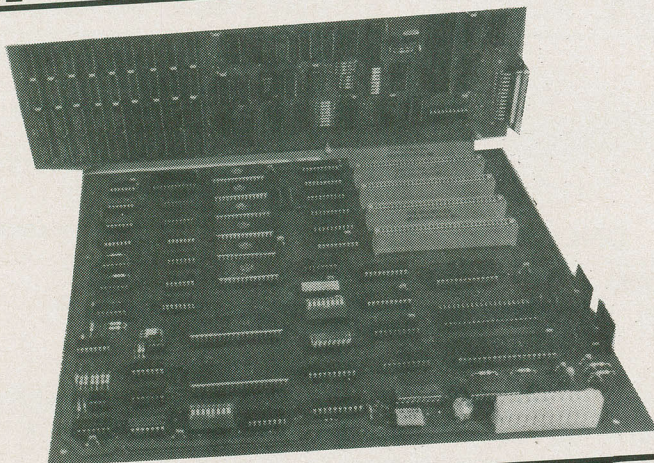
IC1	LM339
IC2	4011B
Q1	2N3904
Q2	TIP31A
Q3	2N2905 (but see text)
Q4	2N3053 (but see text)
D1	18V 400mW Zener
D2	1N4148 or similar
D3	400mW Zener (see Table 1)
LED1,2	Any 0.125" LED
BR1	2A bridge rectifier

## Miscellaneous

PB1,2	Min push-to-make switches
SW1	Two-pole power switch
FS1	1A power fuse and holder
T1	Power transformer, 15V 1A secondary (but see text)

Two 14-pin DIL sockets, case to suit, battery connectors, heatsinks as required (see text).

## IBM PC™ CAPABILITY



Now available with the Parts Galore Venture 88, a bare 16 bit PCB that can be built into a system that will run any program compiled for the IBM PC using the powerful 8088 Intel microprocessor.

- 1) 8088 Mother board with 5 slots, accepts all IBM hardware and all for the low price of only \$119.95
- 2) 64K memory board, expandable to 256K, with RS-232 port (IBM compatible), an excellent PCB at \$89.95
- 3) Manual only (cost credited to Mother board purchase) \$24.95
- 4) To see more, buy the manual, we will credit the full cost of the manual against the purchase price of the Mother board within 3 months. See our ad on page 45 for nice case etc for this PCB. \$24.95
- 5) Edge connectors, set of 5 for Mother board \$24.95

Please note that we do not provide any IBM™ proprietary software or documentation.

IBM, IBM PC™ Registered Trademark IBM Canada Ltd.

**Parts Galore**  
316 College St.  
(416) 925-1105

**Parts Galore Computer Center**

331 Queen St. W.,  
(416) 598-0752



# Expanded Scale Voltmeter Covering The 10-15 V Range



**A simple, low-cost instrument that can be built into power supplies or used as a portable or fixed 'battery condition' monitoring meter.**

COMMON STORAGE batteries to power nominal 12 V DC electrical systems have a terminal voltage that ranges from a little over 10 volts when discharged to around 15 volts when fully charged, the operating voltage being somewhere in the range 11.5 V to 13.8 V. Lead-acid batteries, for example, may have a terminal voltage under rated discharge that commences at around 14.2 V and drops to about 11.8 V. A 12 V (nominal) nickel-cadmium battery may typically have a terminal voltage under rated discharge that starts at 13 volts, dropping to 11 volts when discharged.

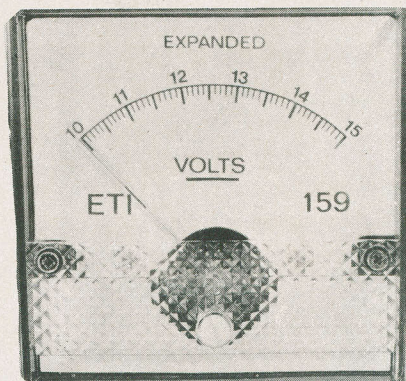
Equipment designed to operate from a nominal 12 V DC supply may only deliver its specified performance at a supply voltage of 13.8 V — mobile CB and amateur transceivers being a case in point. Other DC operated equipment may perform properly at 12.5 V but 'complain' when the supply reaches 14.5 V.

To monitor the state of charge/discharge of a battery, a battery-operated system or the output of power supplies, chargers, etc., a voltmeter which can be easily read to 100 mV over the range of interest, i.e., 10 to 15 volts, is an invaluable asset. This project does just that.

This instrument, being of the true analogue type, is intended for exacting measurement and is better characterized as a test instrument.

## The Circuit

An LM723 variable voltage regulator IC is employed to set an accurate 'offset' voltage of 5 V, and the meter (M1) plus the trimpot RV2 and R3 make up a 5 V meter, with the trimpot allowing calibration. The negative terminal of the meter is connected to the output of the 723 so that it is always held at 5 V 'above' the circuit negative line. The positive end of the meter goes to a zener which will not conduct until more than 5 V appears between the circuit +ve and -ve lines. Thus the meter will not have forward current flowing through it until the voltage between the circuit +ve and -ve rails is greater than



10 V, and will read full scale when it reaches 15 V (after RV2 is set correctly).

The meter scale limits may be adjusted by setting the output of the 723 higher or lower (adjusted by RV1) and setting RV2 so that the meter has an increased or decreased full-scale deflection range.

A variety of meter makes and sizes may be used.

## Construction

Mechanical construction of this project has been arranged so that the pc board can be accommodated on the rear of any of the commonly available moving coil meter movements. We chose a meter with a 55 mm wide scale (overall panel width, 82 mm). A meter movement with a large scale is an advantage as it is considerably easier, and more accurate, to read than meters with a smaller scale. It also pays to buy a 2% fsd accuracy meter for best accuracy.

Having chosen your meter, drill out the pc board to suit the meter terminal

## HOW IT WORKS

The meter, M1, is a 1 mA meter with series resistance — made up of R3 and RV2 — so that it becomes a 0-5 V voltmeter. The negative end of the meter is maintained at 5 V above the circuit negative line by the output of IC1, a 723 adjustable regulator. The positive end of the meter is connected to the circuit positive line via ZD1, a 4V7 zener diode. Thus, no 'forward' current will flow in the meter until the voltage between the circuit negative line and the circuit positive line is greater than  $5 + 4.7 = 9.7$  volts.

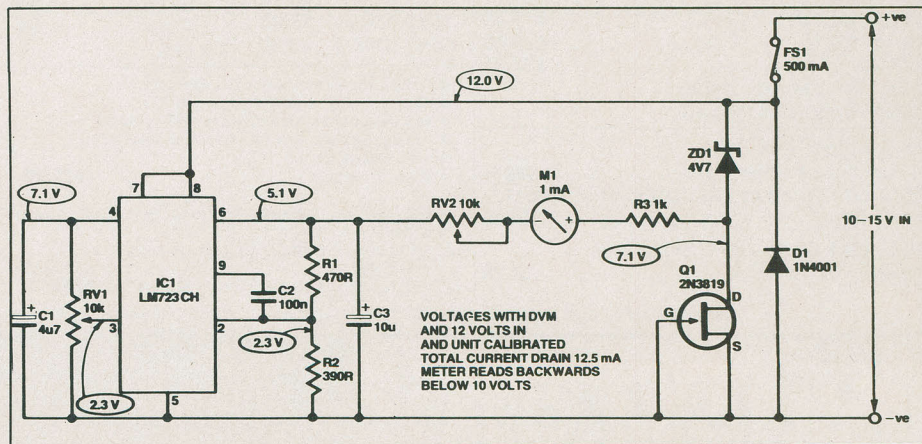
Bias current for the zener is provided by a FET, Q1, connected as a constant current source so that the zener current is accurately maintained over the range of circuit input voltage. This ensures the zener voltage remains essentially constant so that meter reading accuracy is maintained.

The trimpot RV1 sets the output voltage of the 723. This determines the lower scale voltage. Trimpot RV2 sets the meter scale range. More resistance increases the scale range, less resistance decreases it.

Diode D1 protects the circuit against damage from reverse connection.

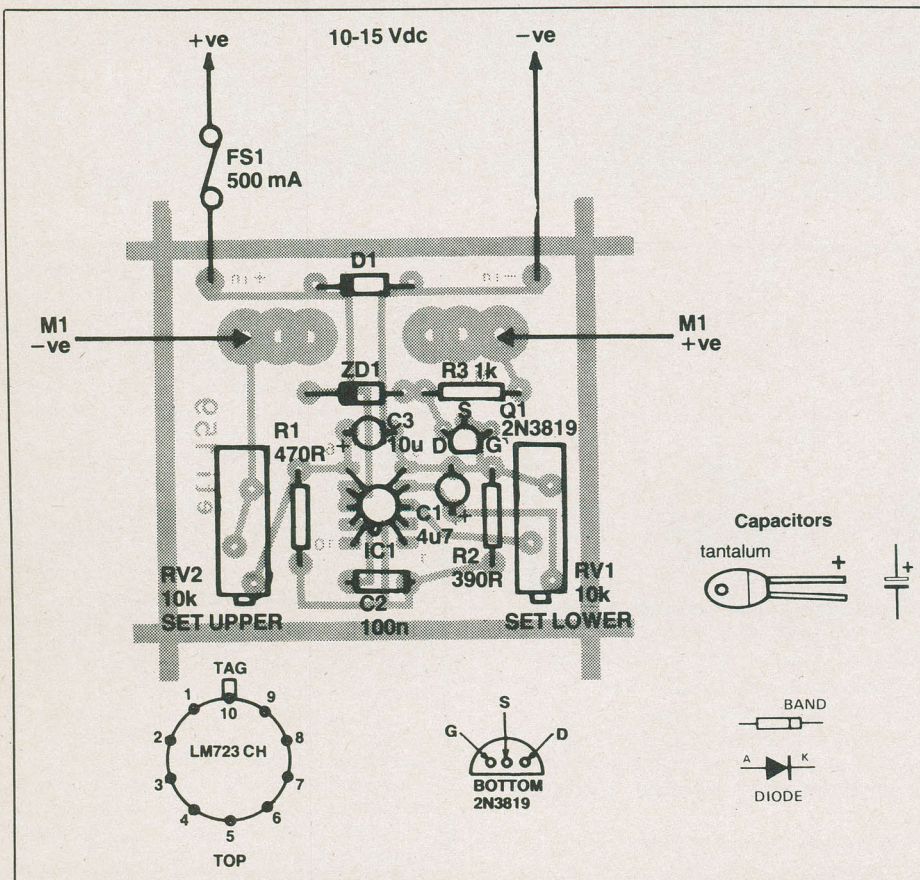
spacing first. The components may then be assembled to the board in any particular order that suites you. Watch the orientation of the 723, ZD1, the FET and particularly D1. The latter is an 'idiot diode'. That is, if you have a lapse of concentration or forethought and connect your project backwards across a battery, the fuse will blow and not the project. Fuses are generally found to be cheaper than this project!

Seat all the components right down on the pc board as the board may be positioned on the rear of the meter with the





## Expanded Scale Voltmeter



components facing the meter. The size of C2 may give you a little trouble. We used a 'Monobloc' type capacitor — as commonly used on computer pc boards as bypasses. Alternatively, a 100n tantalum capacitor (+ve to pin 2 of IC1) may be used. The actual value or type of capacitor is not all that critical.

We have used multiturn trimpots for RV1 and RV2 as they make the setting up a whole lot easier.

### PARTS LIST

#### Resistors (All 1/2W 1% or 2% metal film)

R1	470R
R2	390R
R3	1k
RV1, RV2	10k cermet multiturn horizontal trimpot

#### Capacitors

C1	4u7/10 V tant.
C2	100n ceramic
C3	10u/10 V tant.

#### Semiconductors

IC1	LM723CH
ZD1	4V7, 400 mW or 1W zener
Q1	2N3819
D1	1N4002 or similar

#### Miscellaneous

M1	1 mA meter (see text)
FS1	500 mA fuse and in-line fuse holder
	pc board; meterscale to suit meter.

## MEMORY SPECIAL

4116 150nS MOT	\$1.99
4116 200nS NEC	\$1.75
4864 64K x 1 Hitachi 200NS	\$7.99
2708 1Kx8	\$5.55
2716 2Kx8 Hitachi, NEC	\$4.50
2732 4Kx8 NEC	\$6.99
2764 8K x 8 Mitsubishi	\$10.50
6532	\$7.50
2532	\$7.65
2114 200nS (Hitachi)	\$1.75
2128-2	\$7.99

4164 64K x 1 OKI 150 NS	\$ 8.25
2114 300 NS Hitachi	\$ 1.75
2016 150 NS	\$ 8.25
6116 150 NS	\$ 8.75
27128	\$37.95

Call for quantity price.  
OEM Enquiries Invited.

5 1/4 Mitac Disk Drive with Controller Card	\$339W
5 1/4 double head Panasonic slim Direct Drive	\$299
5 1/4 IBM Compatible Slim Drive (case not included)	\$329

## Japanese Parts Specialists PARTS 100% GUARANTEED

### CPU

Z80	\$5.99
Z80A NEC	\$6.75
6502A 2MHz	\$6.99
6502	\$6.50
6845 CRT Controller (Hitachi)	\$8.99
6522	\$6.99
8088	\$24.50

### Peripherals

8748D NEC	\$24.50
8741 NEC	\$32.50
8251 NEC	\$5.99
8253-5 NEC	\$9.00
8257-5 NEC	\$9.25

### TTL

LS323	4.99
LS08	.35
LS11	.35
LS132	.80
LS107	.35
LS257	.90
LS151	.65
LS194	.90
LS139	.60
LS283	.95
LS367	.80
LS166	1.79
LS377	1.30
LS368	.69
LS86	.55

- 40/80 column automatic display devices.
- easy to install and simple to use.
- software determines to show 40/80 column.
- full instructions and illustration provided.
- inexpensive device
- made in Canada

\$19.95

- 52 function numeric keyboard (electronic touch upper/lower case)
- 5 1/4 Floppy Disk Case (storage up to 150 diskettes)
- YVE High Res non-glare Amber Monitor

\$39.95  
\$169.00

Service Centre and Retail Outlet, 4051 Sheppard Avenue East (at Kennedy), Agincourt, Ontario M1S 1S8 (416) 298-3280

- 40-80 Column Switch
  - Color R.F. Modulator
  - Joystick (Self-centering)
- two adjustable controls
- Parallel Printer Card
  - 16K RAM Card
  - 80 Column Card
  - Disk Controller Card
  - Z80 Card
  - Communication Card

A. 6502 48K KIT or (A&T) \$499.00  
B. 6502 64K KIT or (A&T) \$539.00  
C. 6502 64K built in Z80 or (A&T) \$699.00

ITEMS A, B & C Comes with case and numeric keypad, gold (hydro approved 5 amp power supply)

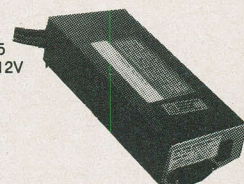
D. 5 amp Teapo Black Power Supply \$99.00

Quality IC Sockets  
Double Side . . . . . 2\*/pin

We repair Power Supply and 6502 Boards

## GOLD Switching Power Supply \$95.00

(+ 5V, 5 AMP, + 12V, 2.5 AMPS, - 5, 1/2 AMP, - 12V - 1/2 AMP). Heavy duty. Hydro approved. Run 2 drives and lots of peripherals. 90 Days Warranty.



Mail Orders: Send a certified cheque or money order plus \$3.00 for shipping and handling. For Special Delivery, please add \$1.00 extra. Ontario residents add 7% P.S.T. Visa & Mastercard accepted.

# Kitstronic

## INTERNATIONAL LTD.

Box 577, Stn. J. Toronto, Ontario.  
M4K 4Z2

Circle No. 8 on Reader Service Card.



## Battery Condition and Terminal Voltage

The 12 V battery, in its many forms, is a pretty well universal source of mobile or portable electric power. There are lead-acid wet cell types, lead-acid gel electrolyte (sealed) types, sealed and vented nickel cadmium types, and so on. They are to be found in cars, trucks, tractors, portable lighting plants, receivers, transceivers, aircraft, electric fences and microwave relay stations — to name but a few areas.

No matter what the application, the occasion arises when you need to reliably determine the battery's condition — its state of charge, or discharge. With wet cell lead-acid types, the specific gravity of the electrolyte is one reliable indicator.

However, it gets a bit confusing as the recommended electrolyte can have a different SG depending on the intended use. For example, a low duty lead-acid battery intended for lighting applications may have a recommended electrolyte SG of 1.210, while a heavy-duty truck or tractor battery may have a recommended electrolyte SG of 1.275. Car batteries generally have a recommended SG of 1.260. That's all very well for common wet cell batteries, but measuring the electrolyte SG of sealed lead-acid or nickel-cadmium batteries is out of the question.

With NiCads, the electrolyte doesn't change during charge or discharge.

Fortunately, the terminal voltage is a good indicator of the state of charge or discharge. In general, the terminal voltage

of a battery will be at a defined minimum when discharged (generally between 10 and 11 volts), and rise to a defined maximum when fully charged (generally around 15 volts). Under load, the terminal voltage will vary between these limits, depending on the battery's condition.

Hence a voltmeter having a scale 'spread' to read between these two extremes is a very good and useful indicator of battery condition. It's a lot less messy and more convenient than wielding a hydrometer to measure specific gravity of the electrolyte!

The charge and discharge characteristics of typical lead-acid and sealed NiCad batteries are given in the accompanying figures.

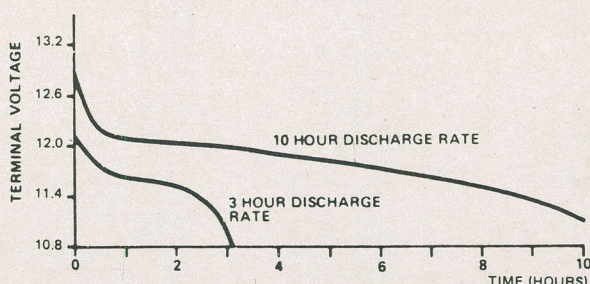


Fig. 1. Typical discharge characteristics of a 12 V (nominal) lead-acid battery.

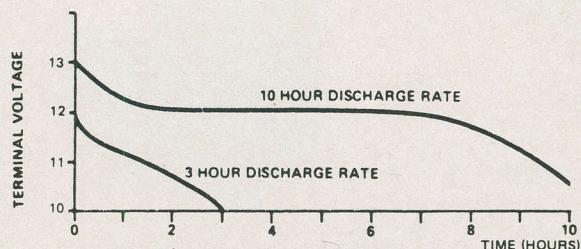


Fig. 3. Typical discharge characteristics of a 12 V (nom.) nickel-cadmium battery (usually consisting of 10 cells in series).

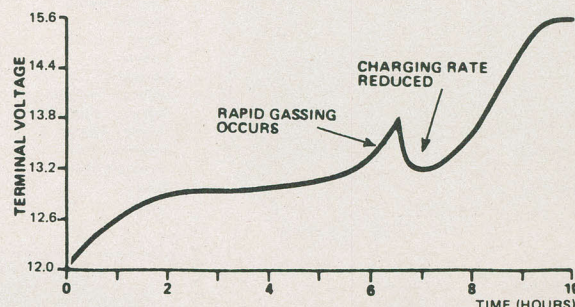


Fig. 2. Charging characteristics of a 12 V (nom.) lead-acid battery. The 'kink' in the curve near 6 hrs is explained in the text.

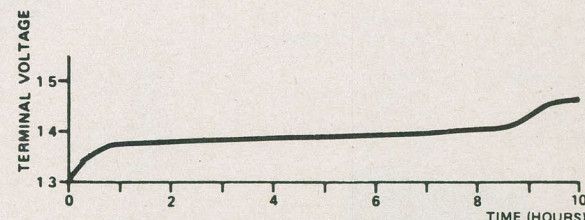


Fig. 4. Typical charging characteristics of a 12 V NiCad battery (10 cells) charged with a constant current at one-tenth rated capacity (0.1C).

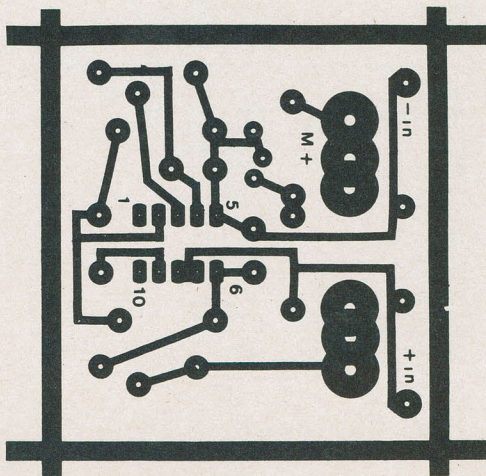
Note that the fuse (to protect the project) is inserted in an in-line holder in the external connecting leads.

## Calibration

For this you will need a variable power supply covering 10 to 15 volts and a digital multimeter (borrow one for the occasion).

First set the 10 V point. Connect the digital multimeter across the power supply output and adjust the power supply to obtain 10.00 volts. Set the mechanical zero on the meter movement to zero the meter's pointer. Connect the unit to the power supply output and adjust RV1 to zero the meter needle.

Next, set the power supply to obtain 15.00 V. Now adjust RV2 so that the



meter needle sits on 15 V (full scale). Check the meter reading with the power supply output set at various voltages across the range. We were able to obtain readings across the full scale within  $\pm$  half a scale reading ( $\pm 50$  mV). With a 2% meter, the worst error may be about  $\pm$  one scale division.

When set up, our unit drew 12.5 mA maximum current drain, which is probably typical, but current drain may be around 20 mA or so maximum. Note that, when the input voltage is below 10 V, the meter needle will move in the reverse direction.

ETI



# Survey of 50 Systems

This month, we conclude last month's survey of fifty lower-cost microcomputers by presenting sixty higher-cost machines. As usual, we apologise for any inaccuracies, and we point out that prices may vary from store to store. Happy drooling.



**System:** Associate  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 65K  
**Printer I/O:** 2 S  
**Disk Drives Inc:** 2 DS DD 5 1/4" floppy  
**Screen Format:** 80x25  
**Graphics:** 32 Graphics Characters  
**Sound:** N  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** Microplan, Spellbinder, acc pak  
**Software Available:** Extensive  
**Primary Market:** Business or Personal  
**Manufacturer:** Associate  
**Available From:** Datacalc Technology Ind Corp.  
**Price:** \$4495.00  
**Other:**



**System:** BASIS 108  
**Operating System:** BASIC  
**Processors:** 6502 & Z80A  
**RAM:** 64K  
**Printer I/O:** P, S & 6 Exp  
**Disk Drives Inc:** Mounting for two 5 1/4" floppy  
**Screen Format:** 80(40)x24  
**Graphics:** 280x192  
**Sound:** Y  
**Colour:** Y  
**Keyboard:** Detachable  
**Software Included:** BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** BASIS Inc.  
**Available From:** Computer Systems Design  
**Price:** \$4000.00  
**Other:** Apple compatible



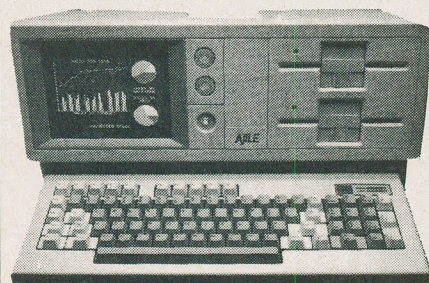
**System:** Orion 1 A  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S & 2 Exp  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** CP/M  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** DY-4 Systems Inc.  
**Available From:** Prelco Electronics  
**Price:** \$4500.00  
**Other:** Multi-user capabilities



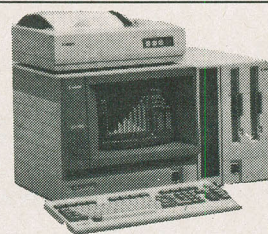
**System:** Columbia VP  
**Operating System:** CP/M-86, MSDOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two 1/2 height DSDD floppy  
**Screen Format:** 80(40)x25  
**Graphics:** 640x200  
**Sound:** Y  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Perfect Series Fast Graphics, BASIC A  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Columbia Data Systems  
**Available From:** Hamax Data Systems  
**Price:** \$4495.00  
**Other:** Portable, IBM PC software compatible

**System:** Xerox 16/8 Prof. Comp  
**Operating System:** Supports CP/M-80, CP/M-86 & MS DOS  
**Processors:** 8086 & Z80A  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Opt 2 floppy or 1 hard, 1 floppy

**Screen Format:** 80x24  
**Graphics:** Opt  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** BASIC  
**Software Available:** Extensive, supports CP/M-80, CP/M-86, MSDOS  
**Primary Market:** Business  
**Manufacturer:** Xerox  
**Available From:** Xerox Stores  
**Price:** Announced in Sept.  
**Other:** Stand-alone or workstation capabilities



**System:** AJILE (portable)  
**Operating System:** MS DOS  
**Processors:** 8088  
**RAM:** 256K  
**Printer I/O:** S & P Exp Module  
**Disk Drives Inc:** One 5 1/4" DS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x250  
**Sound:** Programmable  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Basic, In:Scribe, Multiplan and Communications  
**Software Available:** Extensive, IBM Comp at BIOS  
**Primary Market:** Business  
**Manufacturer:** BYTEC Management Corp.  
**Available From:** Anderson Jacobson Ltd.  
**Price:** \$4285.00  
**Other:**



**System:** Canon AS-100  
**Operating System:** CP/M or DOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** Opt S or P  
**Disk Drives Inc:** Opt 5" or 8" floppy or 5" hard  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** 2 BASICs  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Canon  
**Available From:** Canon Canada Inc.  
**Price:** \$3200.00  
**Other:**

**System:** Heath HZ-89  
**Manufacturer:** Heathkit  
**Available From:** Heathkit  
**Price:** \$2295.00  
**Other:** Kit version of Zenith Z-89

**System:** Heath HZ-100  
**Manufacturer:** Heathkit  
**Available From:** Heathkit  
**Price:** \$3499.99  
**Other:** Kit version of Zenith Z-100

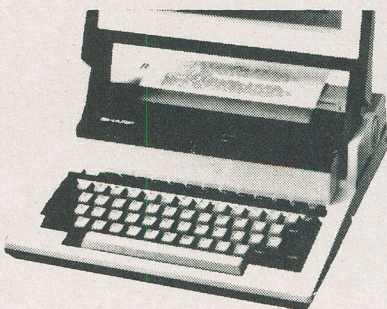


# Computer Survey

**System:** Computer Devices Dot  
**Operating System:** Portable  
**Processors:** MS DOS  
**RAM:** 8088  
**Printer I/O:** 128K  
**Disk Drives Inc:** Two 3 1/2" SS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 1056x254  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** MS DOS  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Computer Devices  
**Available From:** Datamex  
**Price:** N/A  
**Other:** Printer included in price



**System:** Kaypro II  
**Operating System:** CP/M  
**Processors:** Z80  
**RAM:** 64K  
**Printer I/O:** 2 S & P  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** SBASIC, Profitplan, Select  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Kay Computers  
**Available From:** Computron  
**Price:** \$2795.00



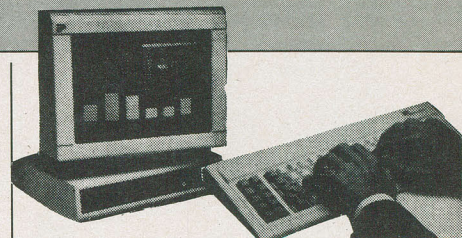
**System:** Sharp PC 5000  
**Operating System:** MS DOS  
**Processors:** 8088 & C-MOS  
**RAM:** 128K  
**Printer I/O:** S  
**Disk Drives Inc:** Opt 128K Bubble Cartridge  
**Screen Format:** 80x8 LCD  
**Graphics:** 640x80  
**Sound:** N  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** MS DOS, BASIC  
**Software Available:** Extensive  
**Primary Market:** Home or Business  
**Manufacturer:** Sharp  
**Available From:** Total Office Systems Inc.  
**Price:** To be announced in Sept.  
**Other:** Portable & printer included

**System:** Sony SMC-70  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S, P & 5 Exp  
**Disk Drives Inc:** Opt SS DD 3 1/2" floppy  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** Y  
**Colour:** Opt  
**Keyboard:** Detachable, Qwerty  
**Software Included:** CP/M  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Sony  
**Available From:** Total Office Systems  
**Price:** \$4900.00

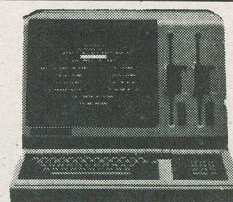


**System:** MAGIC  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S & P  
**Disk Drives Inc:** DSDD IBM Media compatible  
**Screen Format:** 80x24  
**Graphics:** 96 Graphic Characters  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Perfect Writer/Calc/Spell/File  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Magic Computer Co.  
**Available From:** Micro Bazaar  
**Price:** \$2,695.00

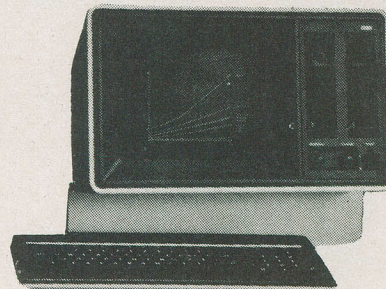
**System:** Nelma Persona  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** 2 S & P  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** OPT  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Wordstar, Calstar and Communication Software  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Nelma Data  
**Available From:** Computerland  
**Price:** \$2995.00



**System:** Pronto 16/10  
**Operating System:** MS DOS  
**Processors:** 80186 (16 Bit)  
**RAM:** 128K  
**Printer I/O:** 2 S, P & 4 Exp  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x25  
**Graphics:** Opt 640x480  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** BASIC, word processor and spread sheet  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Pronto Computers, USA  
**Available From:** To be announced in Sept.  
**Price:** N/A



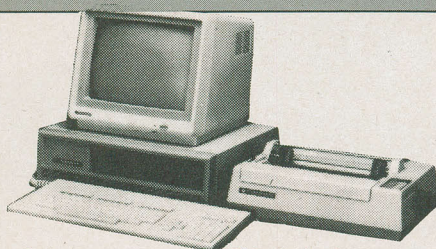
**System:** NEC Advanced Personal Computer  
**Operating System:** CPM, MSDOS  
**Processors:** 8086  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** One or Two 8" floppy  
**Screen Format:** 80x25  
**Graphics:** 640x475 Display Window  
**Sound:** Y  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** CP/M and MSDOS  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** NEC  
**Available From:** Microcomputers of Canada Inc.  
**Price:** \$4 95.00



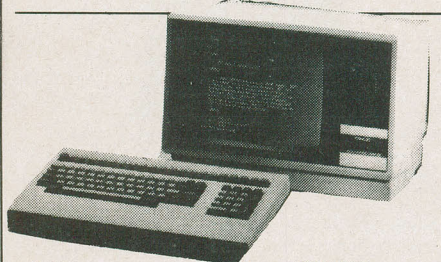
**System:** NCR Decision Mate V  
**Operating System:** Choice  
**Processors:** Z80 & 8088  
**RAM:** 64K  
**Printer I/O:** S & P  
**Disk Drives Inc:** 2 flex or 1 flex & 1 hard  
**Screen Format:** 80x24  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** BASIC, Financial & Word Processor Programs  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** NCR  
**Available From:** SGV Marketing  
**Price:** \$4495.00  
**Other:** Choice of CP/M-80, CP/M-86 or MS DOS



## Computer Survey



**System:** TI Professional  
**Operating System:**  
**Processors:** 8088  
**RAM:** 64K  
**Printer I/O:** S & 5 Exp  
**Disk Drives Inc:** 320K floppy  
**Screen Format:** 80x25  
**Graphics:** 720x300  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:**  
**Software Available:** Supports MSDOS, CPM80, CPM86, USCD  
**Primary Market:** Business  
**Manufacturer:** Texas Instruments  
**Available From:** Lanpar  
**Price:** \$3975.00  
**Other:** Voice management system available



**System:** Tomcat PCX 1600  
**Operating System:** CP/M & MSDOS  
**Processors:** 8086 & Z80A  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two 5 1/4" DS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** CP/M & MS DOS  
**Software Available:** Extensive, IBM Compatible  
**Primary Market:** Business  
**Manufacturer:** Tomcat  
**Available From:** Tomcat Computers  
**Price:** \$3995.00

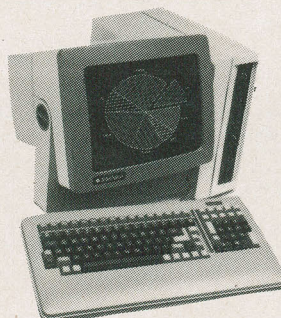


**System:** Osborne Executive  
**Operating System:** CPM & UCSD  
**Processors:** Z80A  
**RAM:** 128K  
**Printer I/O:** 2 S  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:**  
**Sound:** N  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** Wordstar, Mailmerge, Supercalc, Personal Pearl, C & M BASIC  
**Software Available:** Extensive  
**Primary Market:** Home or Business  
**Manufacturer:** Osborne Canada  
**Available From:** Lanpar  
**Price:** \$3495.00

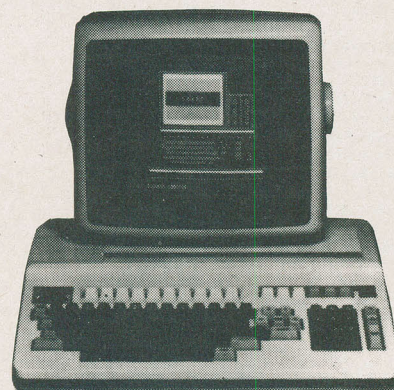


**System:** Sord M23P  
**Operating System:** CP/M Comp  
**Processors:** Pips  
**RAM:** 128K  
**Printer I/O:** 2 S, P & 3 Exp  
**Disk Drives Inc:** Two floppy  
**Screen Format:** 80x25 monitor  
**Graphics:** 640x200  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Integrated  
**Software Included:** BASIC, spread sheet  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Sord  
**Available From:** Micos Computer Systems Inc.  
**Price:** \$2995.00  
**Other:** Opt colour/green/LCD display

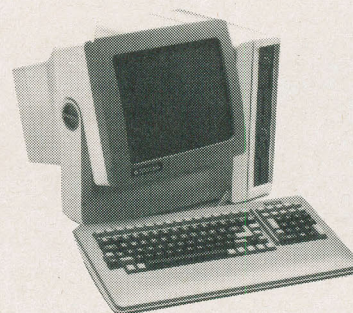
**System:** Telcon Zorba  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** IEEE, P & S  
**Disk Drives Inc:** Two 5 1/4" DS DD floppy disks  
**Screen Format:** 80x25  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Wordstar, Mailmerge, Calcstar, BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Telcon Ind. Inc.  
**Available From:** Micro Bazzar  
**Price:** \$2995.00  
**Other:**



**System:** Televideo TS 1603  
**Operating System:** CP/M  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** Opt  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** CP/M-86 & MMM Ost  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Televideo  
**Available From:** Datamex  
**Price:** \$4420.00



**System:** Sharp YX 3200  
**Operating System:** CP/M & FDOS  
**Processors:** YX-3200  
**RAM:** 64K  
**Printer I/O:** P & S Exp  
**Disk Drives Inc:** Opt 5 1/4" or 8" floppy  
**Screen Format:** 80x25  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** 2 BASICS  
**Software Available:** Extensive  
**Primary Market:** Home or Business  
**Manufacturer:** Sharp  
**Available From:** Total Office Systems  
**Price:** \$2395.00



**System:** Televideo TS 803  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** 640x240  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** CP/M  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Televideo  
**Available From:** Datamex  
**Price:** \$3704.00

**System:** Sord M68  
**Operating System:**  
**Processors:** MC68000, Z80A  
**RAM:** 256K  
**Printer I/O:** 2 S, P & IEEE  
**Disk Drives Inc:** Two 5" mini floppy  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** Not available  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Sord  
**Available From:** Micos Computer Systems Inc.  
**Price:** Announced in Sept.



# Wouldn't you like to have a new skill you could call your own? Learn TV, audio, and video servicing with at-home training from NRI.

You can learn to service and repair TVs, stereos, electronic musical instruments and amplifiers, car and portable radios, record and tape decks, videocassette recorders and disc players, almost any kind of electronic equipment on the market. And you can learn to do it at home, in your spare time, without quitting your job or wasting time and gasoline on night school. NRI will train you. We've trained over a million and a quarter others, with effective methods proven over 69 successful years.

## Hands-On Training

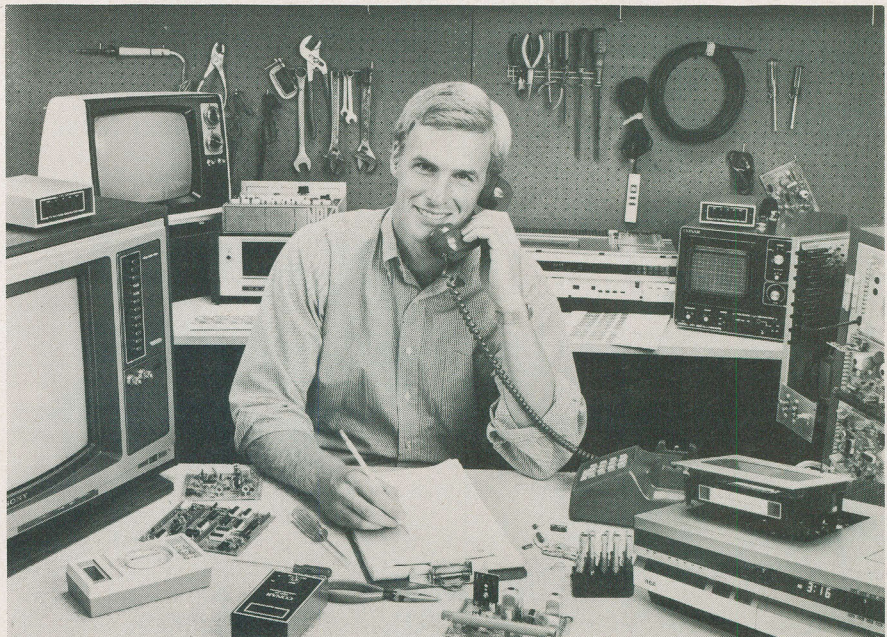
NRI training is practical training all the way. Throughout your course, you'll perform hands-on experience projects that make theory come to life and give you real understanding.

## Includes Both 25" TV and VCR, Plus DMM and More

As part of your training, you'll build your own 25" Heath/Zenith color TV a state-of-the-art unit with infrared remote tuning, programmable channel selection, and the incredible space phone



Learn by doing with NRI hands-on projects and professional instruments that you use and keep.



for remote calling. You also get a front-loading remote-controlled videocassette recorder to play your videotaped lessons and learn about servicing this complex instrument.

You'll learn troubleshooting techniques using a professional 3½-digit digital multimeter. You'll use it when assembling your TV to check demonstration circuits you build on the NRI Discovery Lab, and in your professional work. It's the equipment and training you need for success.

## Exclusive NRI Training on Videotape

In addition to profusely illustrated lessons, you get NRI Action Videocassettes . . . videotaped lessons that show you graphic presentations of electronic systems, vivid closeups of servicing techniques and professional "shortcuts" to study and replay as often as you want.

## Training For Success

NRI not only prepares you to become a top technician, we get you ready for independence. NRI Video/Audio servicing gives you a great new way to earn extra money doing part-time servicing for appliance and department stores . . .

building a good-paying new career with an electronics firm . . . or even starting your own business. You can start small, even part-time in your basement or garage, make the most of your opportunities to grow into a successful businessman.

## Free Catalog . . . Mail Card Today

Send the postage-paid card for our free 104-page color catalog describing our courses in full, showing all equipment, lesson outlines, and career opportunities. It also shows other exciting courses like Microcomputers, Electronics Design, Industrial Electronics, Digital Electronics, and more. Mail the postage-paid card today for your copy, and see how you can make the most of your talent. If card has been removed, please write to:



**NRI SCHOOLS**  
McGraw-Hill Continuing  
Education Center  
330 Progress Avenue  
Scarborough, Ontario M1P 2Z5  
or telephone 416-293-8787

**We'll give you tomorrow.**

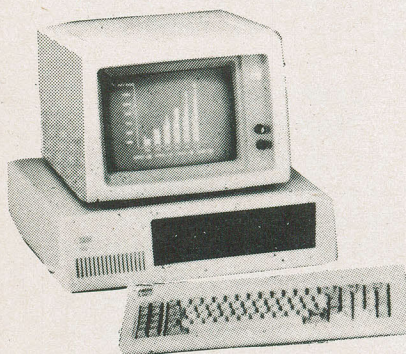


## Computer Survey



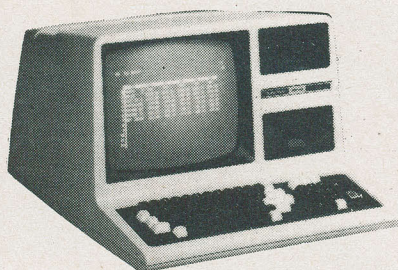
**System:** Tomcat 3000  
**Operating System:** MSDOS, CP/M-80, CP/M-86  
**Processors:** 8086 & Z80A  
**RAM:** 128K  
**Printer I/O:** 2 S  
**Disk Drives Inc:** 8" floppy, 5 1/4" hard  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** CP/M-86, CP/M-80, MS-DOS  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Tomcat  
**Available From:** Tomcat Computers  
**Price:** N/A

**System:** Intertec SUPERBRAIN II JR  
**Operating System:** DOS & CP/M  
**Processors:** Twin Z80A  
**RAM:** 64K  
**Printer I/O:** 2 S  
**Disk Drives Inc:** Two 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** CP/M, DOS, BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Intertec Data System  
**Available From:** E.M.J. Data Systems  
**Price:** \$2495.00



**System:** IBM PC  
**Operating System:** DOS, UCSD P-System & CP/M-86  
**Processors:** 8088  
**RAM:** 64K  
**Printer I/O:** 13 Exp.  
**Disk Drives Inc:** One 160KB Diskette  
**Screen Format:** 80x25  
**Graphics:** 640x200  
**Sound:** N  
**Colour:** Opt.  
**Keyboard:** Detachable  
**Software Included:** Operating Systems  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** IBM  
**Available From:** Local Dealers  
**Price:** \$3,200.00  
**Other:** Opt. auxiliary storage with Expansion unit.

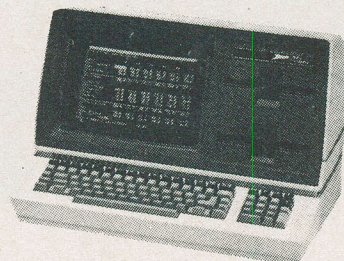
**System:** Commodore BX 128-80  
**Operating System:** CBM  
**Processors:** 6509 & 8088  
**RAM:** 128K  
**Printer I/O:** IEEE & S  
**Disk Drives Inc:** Opt disks  
**Screen Format:** 80x25  
**Graphics:** 720x350  
**Sound:** Y  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** N/A  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Commodore  
**Available From:** Local Dealers  
**Price:** N/A  
**Other:** Also available with 256K



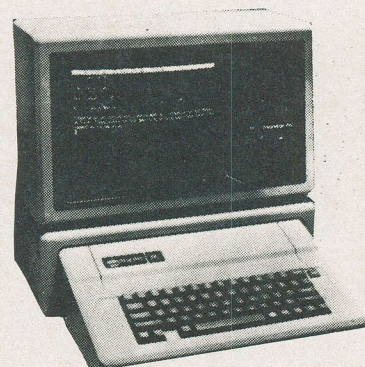
**System:** TRS-80 Model 4  
**Operating System:** TRS DOS  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** P  
**Disk Drives Inc:** Two SSD 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** Opt 640x240  
**Sound:** Programmable  
**Colour:** N  
**Keyboard:** Integrated  
**Software Included:** TRS DOS, BASIC  
**Software Available:** COMP CP/M, LDOS  
**Primary Market:** Business  
**Manufacturer:** Tandy  
**Available From:** Radio Shack  
**Price:** \$2999.00  
**Other:**



**System:** Zenith Z-89  
**Operating System:** Choice  
**Processors:** Z-80  
**RAM:** 48K  
**Printer I/O:** Y  
**Disk Drives Inc:** 100K  
**Screen Format:** 80x25  
**Graphics:** Character symbols  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Integrated  
**Software Included:** CP/M and/or ZDOS  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Zenith  
**Available From:** Local dealers  
**Price:** \$3745.00



**System:** Zenith Z-100  
**Operating System:** Choice  
**Processors:** 8088 & 8085  
**RAM:** 128K  
**Printer I/O:** 2 S & 1 P  
**Disk Drives Inc:** One 5 1/4" floppy DS DD  
**Screen Format:** 80x24  
**Graphics:** 225x640  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Integrated  
**Software Included:** CP/M and/or ZDOS  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Zenith  
**Available From:** Local dealers  
**Price:** \$4675.00



**System:** Apple IIe  
**Operating System:** DOS  
**Processors:** 6502A  
**RAM:** 64K  
**Printer I/O:** 8 Exp. slots  
**Disk Drives Inc:** Opt. 5 1/4" floppy  
**Screen Format:** 80x24  
**Graphics:** 280x192  
**Sound:** Y  
**Colour:** Y  
**Keyboard:** Integrated  
**Software Included:** DOS, BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Apple Canada  
**Available From:** Local Dealers  
**Price:** \$2895.00  
**Other:** \$2995.00 — 128K

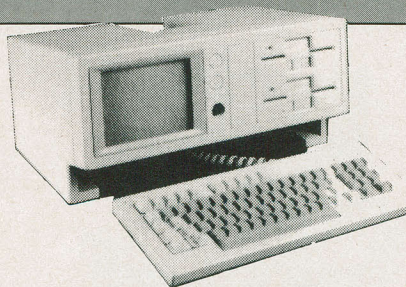
**System:** Heath HZ-89  
**Manufacturer:** Heathkit  
**Available From:** Heathkit  
**Price:** \$2295.00  
**Other:** Kit version of Zenith Z-89

**System:** Heath HZ-100  
**Manufacturer:** Heathkit  
**Available From:** Heathkit  
**Price:** \$3499.99  
**Other:** Kit version of Zenith Z-100

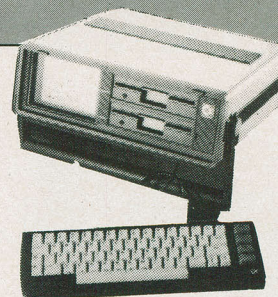




**System:** Columbia VP  
**Operating System:** CP/M-86, MSDOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two 1/2 height DSDD floppy  
**Screen Format:** 80(40)x25  
**Graphics:** 640x200  
**Sound:** Y  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Perfect Series Fast Graphics, BASIC A  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Columbia Data Systems  
**Available From:** Hamax Data Systems  
**Price:** \$4495.00  
**Other:** Portable, IBM PC software compatible



**System:** Hyperion  
**Operating System:** MS DOS  
**Processors:** 8088  
**RAM:** 256K  
**Printer I/O:** S, P & IEEE  
**Disk Drives Inc:** Two 5 1/4" DS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x250  
**Sound:** Programmable  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Multiplan, text editor, 2 others  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** BYTEC Mang. Corp.  
**Available From:** Computerland  
**Price:** \$4950.00  
**Other:** IBM compatible, portable

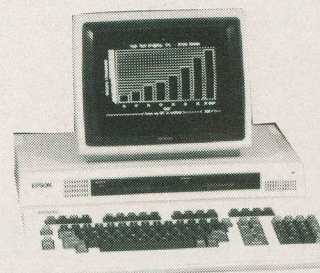


**System:** Commodore Executive 64  
**Operating System:** Basic  
**Processors:** 6510  
**RAM:** 64K  
**Printer I/O:** S & IEEE  
**Disk Drives Inc:** 170K single disk drive  
**Screen Format:** 40x25  
**Graphics:** 320x200  
**Sound:** Y  
**Colour:** Y  
**Keyboard:** Detachable  
**Software Included:** Not finalized  
**Software Available:** CBM 64 software compatible  
**Primary Market:** Business  
**Manufacturer:** Commodore  
**Available From:** Local dealers  
**Price:** To be announced in the Fall  
**Other:** Portable



**System:** Olivetti M20  
**Operating System:** PCOS  
**Processors:** Z8001  
**RAM:** 128K  
**Printer I/O:** S, P & 5 Exp.  
**Disk Drives Inc:** DDDS 5 1/4" floppy  
**Screen Format:** 80x25  
**Graphics:** 512x256  
**Sound:** N  
**Colour:** Opt.  
**Keyboard:** Integrated  
**Software Included:** PCOS, BASIC, Tutorials  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Olivetti  
**Available From:** KSO Sales Agency Ltd.  
**Price:** \$4170.00

**System:** Hewlett-Packard 200 Model 16  
**Operating System:** Opt  
**Processors:** MC68000  
**RAM:** 128K  
**Printer I/O:** S & IEEE  
**Disk Drives Inc:** 80x25  
**Screen Format:** 300x400  
**Graphics:** N  
**Sound:** N  
**Colour:** Detachable  
**Keyboard:** Choice of BASIC, HPL or PASCAL  
**Software Included:** Extensive  
**Software Available:** Business  
**Primary Market:** Hewlett Packard  
**Manufacturer:** Hewlett Packard  
**Available From:** Hewlett Packard  
**Price:** \$6079.00



**System:** Epson QX-10  
**Operating System:** Valdocs  
**Processors:** Z80A  
**RAM:** 256K  
**Printer I/O:** S, P & 5 Exp  
**Disk Drives Inc:** Two 5 1/4" DS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Indexer, Word Processor, Mail System, Graphics  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Epson  
**Available From:** ESSNA  
**Price:** \$4300.00  
**Other:** CP/M Compatible



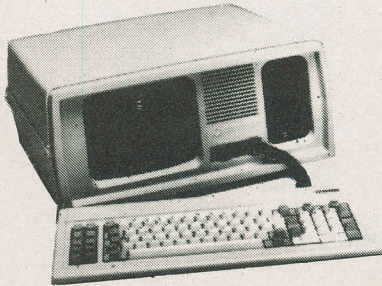
**System:** Olympia "People"  
**Operating System:** CP/M & MSDOS  
**Processors:** 8086  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two floppy disk drives  
**Screen Format:** 80x25  
**Graphics:** 600x485  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** Wordstar, Supercalc, D BASE II  
**Software Available:** Extensive  
**Primary Market:** Home or Business  
**Manufacturer:** Olympia Int.  
**Available From:** Olympia Bus Machines Can Ltd.  
**Price:** \$5950.00

**System:** Victor 9000  
**Operating System:** CP/M, MSDOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** 2 S & 2 P  
**Disk Drives Inc:** Two 5 1/4" SS floppy  
**Screen Format:** 132(80)x25  
**Graphics:** 800x400  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Operating systems, BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Victor  
**Available From:** Compucollege Stores  
**Price:** \$5495.00

**System:** Hitachi MB 16001  
**Operating System:** DOS, CP/M  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S, P & 5 Exp  
**Disk Drives Inc:** DS DD 8" floppy  
**Screen Format:** 80x25  
**Graphics:** 640x400  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** MS DOS, CP/M, BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Hitachi  
**Available From:** Hitachi (HSC) Canada In.  
**Price:** \$5000.00



## Computer Survey



**System:** Corona Portable  
**Operating System:** MSDOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S & P  
**Disk Drives Inc:** One half size floppy  
**Screen Format:** 80x24  
**Graphics:** 640x325  
**Sound:** Y  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Multimate, 2 Tutorials  
**Software Available:** Extensive, 4 IBM Compatible slots  
**Primary Market:** Business  
**Manufacturer:** Corona  
**Available From:** Scarsdale Computers  
**Price:** \$3880.00



**System:** Corona Personal  
**Operating System:** MSDOS  
**Processors:** 8088  
**RAM:** 128K  
**Printer I/O:** S and P  
**Disk Drives Inc:** One SS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x325  
**Sound:** Y  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Multimate, 2 Tutorials  
**Software Available:** Extensive, 4 IBM Compatible slots  
**Primary Market:** Business  
**Manufacturer:** Corona  
**Available From:** Scarsdale Computers  
**Price:** \$3880.00  
**Other:** Can mix text and graphics

**System:** Cromemco C-10SP  
**Operating System:** CP/M COMP  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two 5 1/4" floppy DSDD  
**Screen Format:** 80x25  
**Graphics:** N/A  
**Sound:** N  
**Colour:** N  
**Keyboard:** Detachable  
**Software Included:** Word Processor, Spreadsheet & BASIC  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Cromemco  
**Available From:** NSN Options  
**Price:** \$2495.00

**System:** Toshiba T 100  
**Operating System:** CP/M  
**Processors:** Z80A  
**RAM:** 64K  
**Printer I/O:** S & P  
**Disk Drives Inc:** Two 5 1/4" DS DD floppy  
**Screen Format:** 80x25  
**Graphics:** 640x200  
**Sound:** N  
**Colour:** Opt  
**Keyboard:** Detachable  
**Software Included:** 2 BASICS, Word Processor, Spread Sheet & Data Base  
**Software Available:** Extensive  
**Primary Market:** Business  
**Manufacturer:** Toshiba  
**Available From:** PWT Computer Group  
**Price:** \$2995.00

## WHY SPEND A FORTUNE ON A DIGITAL CAPACITANCE METER?

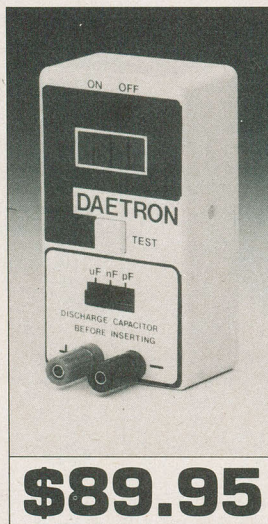
As a matter of fact you don't have to pay \$200 to \$500 and up anymore for a Digital Capacitance Meter that is both dependable and rugged with good accuracy. The MC100A comes completely assembled and calibrated and at \$89.95 is an outstanding value. The extensive range of 30 pF to 9,999 uF (no external meters required) and true hand held portable size (only 4 1/4" x 2 1/2" x 1 1/2") make the MC100A an extremely practical and easy to use instrument for the hobbyist technician or engineer.

### CHECK THESE OTHER FEATURES

- \* Basic accuracy 2% ( $\pm$  one count) on pF, nF ranges, 5% ( $\pm$  one count) on uF range.
- \* Uses single 9V battery (not included).
- \* Decimal points light up when battery is low or when capacitor is overrange.
- \* Full 4 digit high efficiency LED display uses special circuitry to save on batteries.
- \* Maximum conversion time for 9,999 uF is less than 6 seconds.
- \* Constructed with a tough impact resistant plastic case.
- \* 90 day parts and labour warranty.



**DAETRON**  
 935 THE QUEENSWAY, BOX 641  
 TORONTO, ONTARIO M8Z 5Y9  
 (416) 499-7221  
 DEALER ENQUIRIES INVITED



**\$89.95**

### PLEASE SEND ME

(Quantity) MC100A(s) @ \$89.95

Ontario residents add 7% PST

Postage — \$1.85 (per instrument) (C.O.D. orders add \$1.59)

☐ I ENCLOSE CHEQUE ☐ MONEY ORDER ☐ BILL MY VISA

☐ VISA CARD NO.

EXPIRY DATE

SIGNATURE

Immediate shipping on orders with money orders, VISA or certified cheque.

Personal cheques please allow 2 to 3 weeks for clearance.

NAME

ADDRESS

CITY

PROV.

POSTAL CODE

TOTAL \$

MAIL TO DAETRON 935 THE QUEENSWAY BOX 641 TORONTO ONTARIO M8Z 5Y9

Circle No. 30 on Reader Service Card.

**CHRISTMAS SPECIALS**

**Gentek Computers Inc.**

**PRESENTS**

**A Computer Saleabration**



• **DISC FILERS**  
 (Holds 50 Discs) \$29.95  
 (Holds 100 Discs) \$37.95

• **SPEECH/MUSIC SYNTHESIZERS**  
 C/W Software & Manual \$99.95

• **JOYSTICKS** - Auto Center \$34.95  
 - Manual \$19.95

• **MITAC-MATE 1 DISC DRIVE** \$269.00

**UNITRON U2200 - MICRO COMPUTER**



- APPLE™/CPM™ COMPATIBLE  
 - DUAL MICROPROCESSOR Z80/6502  
 - 64K RAM (UPGRADABLE TO 256K RAM)  
 - MULTI-FUNCTION DETACHED KEYBOARD

- DUAL DISC INTERFACE  
 - COMPLETE PKGS. AVAIL.

**FOR MORE INFORMATION & PRICES CALL:**

**877 ALNESS ST., UNIT 18, DOWNSVIEW, ONT. M3J 2X4**

**(416) 665-0234**

OR

**IN QUEBEC (514) 489-0359/0427**



Circle No. 11 on Reader Service Card.





System: Apple III  
Operating System: SOS  
Processors: 6502B  
RAM: 256K  
Printer I/O: S & 4 Exp.  
Disk Drives Inc: One 5 1/4" DD floppy  
Screen Format: 80x24  
Graphics: 560x192  
Sound: Opt.  
Colour: Opt.  
Keyboard: Integrated  
Software Included: SOS  
Software Available: Extensive  
Primary Market: Business  
Manufacturer: Apple  
Available From: Local Dealers  
Price: \$3895.00

#### ADDRESSES:

Anderson Jacobson Canada Ltd., 32 Don Mills Rd., Markham, Ontario, L3R 1C2. (416) 475-5510.

Apple Canada, 875 Don Mills Rd., Don Mills, Ontario, M3C 1V9. (416) 444-2531.

Canon Canada Inc., 3245 American Dr., Mississauga, Ontario, L4V 1N4. (416) 678-2730.

Commodore Business Machines, 3370 Pharmacy Ave., Agincourt, Ont, M1W 2K4. (416) 499-4292.

Computer Land, 3761 Victoria Park #5, Scarborough, Ontario, M1W 2S6. (416) 497-5722.

Computer Systems Design, P.O. Box 32, Lake Wilcox, Ontario, L0G 1X0. (416) 773-0467.

Computron, 55 Torbay Road, Markham, Ontario, L3R 1G7. (416) 447-0828.

Data Calc Technology Ind. Corp., 224 Slater Rd., Cranbrook, British Columbia. (604) 489-5343.

Datamex, 14 Leswin Rd., Toronto, Ontario, M6A 1K2. (416) 781-9135.

EMJ Data Systems, 79 Regal Rd., Unit 5, Guelph, Ontario, N1K 1B6. (519) 837-2444.

Essna Services Ltd., 31 Progress Court, Unit 1, Scarborough, Ontario, M1G 3V5. (416) 438-8060.

Hamax Data System, 1262 Don Mills Rd., Don Mills, Ont., M3B 2W7. (416) 447-5587.

Heathkit, 1478 Dundas St. East, Mississauga, Ontario, L4X 2R7. (416) 277-3191.

IBM Canada Ltd., 3500 Steeles Ave. East, Markham, Ontario, L3R 2Z1. (416) 474-2111.

KSO Sales Agency Ltd., 1262 Don Mills Rd., Unit 72, Don Mills, Ontario, M3B 2W7. (416) 441-2869.

Lanpar, 85 Torbay Rd., Markham, Ontario, L3R 1G7. (416) 475-9123.

Micro Bazaar, 23 Westmore Dr., Unit 5, Rexdale, Ontario, M9V 3Y7. (416) 745-4740.

Micos Computer Systems Inc., 1295 Eglinton Ave. East, Cooksville, Ontario, L4W 3E6. (416) 624-0320.

Micro Computers of Canada Inc., 3410 Midland Ave., Unit 6, Scarborough, Ontario. (416) 293-3885.

NSN Options, 250 Wyecroft Rd., Unit 11, Oakville, Ontario, L6K 3T7. (416) 842-6530.

Prelco Electronics, 2767 Thamesgate Dr., Mississauga, Ont., L4T 1G2. (416) 678-0401.

PWT Computer Group, 1305 Matheson Blvd., Mississauga, Ontario, L4W 1R1. (416) 624-7455.

Radio Shack Computer Centre, 329 Bay St., Toronto, Ontario. (416) 365-7207.

Scarsdale Computers, 1 Scarsdale Rd., Don Mills, Ontario, M3B 2E2. (416) 441-1900.

SGV Marketing 1520 Trinity Dr. Unit 16, Mississauga, Ontario, L5T 1T6. (416) 673-2323.

Tomcat Computers of Canada Inc., 6299 Airport Rd. Suite 404, Mississauga, Ontario, L4V 1N3. (416) 673-2040.

Total Office Systems Ltd., 1050 McNicoll Ave., Unit 14, Scarborough, Ontario, M1W 2L8. (416) 493-3575.

Xerox Store, 110 Eglinton Ave. East, Toronto, Ontario. (416) 482-6111.

Zenith Data Systems, 1020 Islington Ave., Toronto, Ontario, M8Z 5X5. (416) 231-4171.

ETI

## FASTRON COMPUTER INC.

250 DUNDAS ST. W. (AT UNIVERSITY) TORONTO, ONTARIO M5T 2Z1

TEL: (416) 591-9217

6502 CPU 48K .....	\$297.00	12" Amber .....	\$189.00
Numeric Keyboard .....	\$ 99.00	Nonglare Monitors	
5A Power Supply .....	\$ 88.00	12" Disco Green .....	\$189.00
Numeric Case .....	\$ 66.00	12" Amber .....	\$198.00
Complete Kit .....	\$550.00		

Disk Controller .....	\$ 59.00	Epson Printer .....	\$499.00
16K RAM Card .....	\$ 59.00	CP-80 .....	\$550.00
Z80 CP/M .....	\$ 73.00	Slim Drive .....	\$315.00
80 Col. Card .....	\$ 85.00	Mitac Drive .....	\$315.00
Printer Card .....	\$ 78.00	Micro-Sci .....	\$325.00

Voice Synthesizer .....	\$ 75.00	Memorex Disk (10) .....	\$ 29.75
Eprom Writer .....	\$ 98.00	BASF Disk (10) .....	\$ 29.75
Wild Card .....	\$ 98.00	CDC Disk (12) .....	\$ 29.50
RS232 Card .....	\$ 88.00	Disk Bank .....	\$ 3.99
System Fan .....	\$ 50.00	Printer Paper .....	14/M
		Joystick .....	\$ 27.00

Game Tape .....	\$ 7.00	IBM PC with 320K Drive	Call
Game Disk .....	\$ 10.00	2nd 320K Drive .....	\$ 335
		Microsoft Mouse .....	\$ 252

#### ZENITH MONITORS

12" Green .....	\$129.00	Microprofessor 64K ...	\$ 675
12" (New) Green .....	\$149.00	Magic Computer .....	\$ 2,205
		Coleco Adam .....	\$ 788

#### MAIL ORDERS

Add \$3.00 for shipping & handling. Ontario residents add 7% P.S.T. VISA, MASTERCARD and AMERICAN EXPRESS cards accepted: send card number, expiry date, name of bank and signature. Send certified cheque or money order. Do not send cash. No C.O.D. please.

COMPUTERS • SOFTWARE • COMPONENTS • ACCESSORIES • BOOKS • RENTAL

## ETI Classified's Work!

One of the best ways to judge if other advertisers are getting good results from a publication is to see if the space booked is stable, going down or increasing.

Classified ads in ETI have increased 88% in the last seven months. In addition ETI circulation is still increasing giving better and better value.

Reach 30,000 Canadian readers for as little as \$20.



# Designing Micros Part 4

**Last month, Owen Bishop explained what a ROM chip is. This month, he tells you why. Read on.**

A short program which enables the MPU to get started on its more important tasks is called a *boot-strap program*. It helps the MPU pull itself up by its bootstraps! Since such a program must already be in the computer from the moment power is switched on, the obvious course is to place this program there permanently in ROM. Most computers have additional ROM programs to instruct the MPU how to do other kinds of routine jobs, such as send output to the display. Quite often a message such as "APPLE II" or "MEMORY SIZE?" is placed on the screen when the computer is switched on. The program to do this is held in ROM. The complete program may occupy a few kilobytes of memory. Such a program is generally called a *monitor program*. This is another use of the word 'monitor', the name usually given to a purpose-built computer video display (as opposed to a domestic TV set being pressed into service as a computer display).

The monitor program is usually written in machine code (see October's article), for this is the most compact way of instructing the MPU and allowing it to operate at its maximum speed. Most computer users prefer to communicate with the MPU by using a high-level language, such as BASIC. MPUs do not understand BASIC, so a program written in machine code is needed to interpret programs written in BASIC. Then the MPU can understand what it must do. The interpreting program (or interpreter) can be loaded from tape or disk into RAM, but since such a program is likely to be required every time the computer is used, it is more convenient to hold it in ROM. Thus the ROM of a microcomputer may have, say, 12K of ROM which holds all the routines (in machine code) for interpreting BASIC commands and executing them.

When buying a microcomputer it is essential to find out whether you need to buy BASIC on a disk and load it every time you want to use it, or whether the BASIC is resident in ROM. Usually the memory space quoted for a computer is

the amount of RAM it has. A computer which is listed as having 48K will allow you to use almost the whole of that for your programs if its BASIC is in ROM. On the other hand, if the computer has 56K but no resident language, the language may use up 12K of that space when loaded in RAM, leaving you with only 44K for your own programs.

## A Change Of Character

Another use for ROM is to hold tables which are to be frequently used by the computer. A good example is the 'character generator' ROM. Before it can put a character onto the screen, the MPU must find out exactly what pattern of dots are required to produce the letter, numeral, or symbol that is to be displayed. These patterns are held in the character generator ROM. The MPU

reads the appropriate pattern from the ROM and sends it to the video area of RAM, causing the character to be displayed.

It is feasible to manufacture several different character generator ROMs, each containing a different selection of characters. There can be different type-faces, or the selection of letters and symbols can be chosen according to the country in which the computer is to be used. For example, Video Inc. manufactures a series of such EPROMs for the Apple II including the French, German, Spanish and Katakana (Japanese) alphabets, and one holding mathematical and Greek symbols.

Another type of plug-in ROM which is widely used holds a complete games program, educational program, or utility program. Instead of loading the program

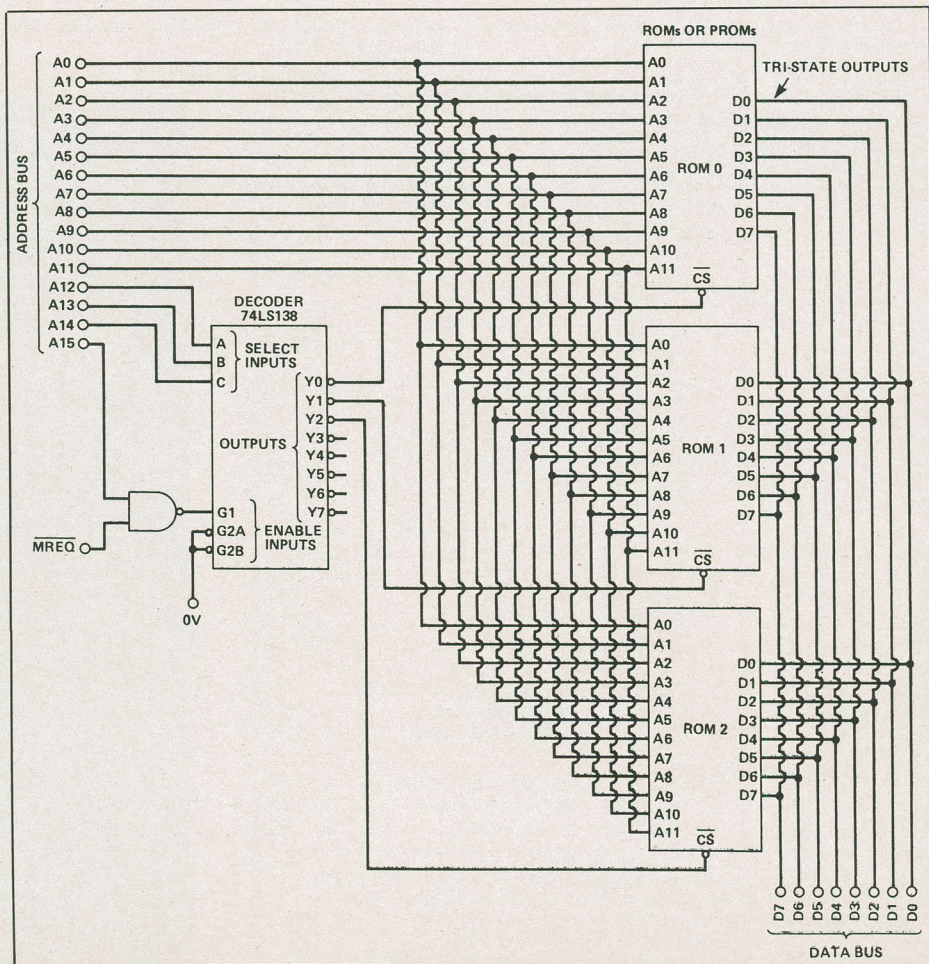


Fig. 1. Addressing three 4K ROMs.



TABLE 1

ROM NO.	ADDRESS RANGE		
	DECIMAL	HEXADECIMAL	BINARY
0	0 to 4095	0000 to 0FFF	0000 0000 0000 0000 to 0000 1111 1111 1111
1	4096 to 8191	1000 to 1FFF	0001 0000 0000 0000 to 0001 1111 1111 1111
2	8192 to 12287	2000 to 2FFF	0010 0000 0000 0000 to 0010 1111 1111 1111

from tape or disk, the user simply plugs in a module containing a pre-programmed ROM. The Atari and Tandy TRS-80 Colour Computer are examples of machines with this facility, as are many of the more specialized TV games machines.

### Addressing Memory

We have often referred to the MPU addressing a given byte in memory at a particular address, without giving any indication of how this is done. Let us look into this in a little more detail. As an example, consider a ROM (it might be a regular mask-programmed ROM or some type of PROM) which stores 4 kilobytes. Each bit of these 4096 bytes is represented by a memory cell. This very-large-scale integrated circuit (VLSI) therefore contains 32768 memory cells, each consisting of a transistor which is set on or off depending

upon whether it corresponds to a 0 or a 1. It also contains the logic circuits required to ensure that when any one of the 4096 possible combinations of voltage levels (the 4K addresses) is put on the lower 12 lines of the address bus (lines A11 to A0), the eight bits of information stored by the corresponding eight transistors will be gated onto the eight lines of the data bus.

The extreme complexity of such a circuit is difficult to imagine, yet it is commonplace on the computer circuit board. To accommodate a monitor program and a resident language we may need three such ICs, giving a total ROM memory of 12K. Suppose that this is to run from the very bottom of the computer's memory (from address 0000 onwards). The addresses corresponding to the three ICs will be shown in Table 1. From the binary address it is clear that the lower 12 address

lines are responsible for differentiating between all the addresses held in a single ROM. The state of the upper four address lines (A15 to A12) tell us which, if any, of the three ROMs is to be addressed at any particular time. Thus the address 4295 (10C7 in hex) appears on the bus as:

0001 0000 1100 0111

and refers to ROM1. The address 8391 (20C7 in hex) appears on the bus as:

0010 0000 1100 0111

and is located in ROM2. All three ROMs receive the signals on lines A11 to A0. How can we ensure that only ROM1 responds to the address 10C7, while only ROM2 responds to 20C7?

## BRUNELLE presents THE Commander SERIES Model 4060 Digital

ALL  
THAT THE  
NAME  
IMPLIES

The Multimeter you've been waiting for...  
at the price you've been hoping for!

**\$114.95**

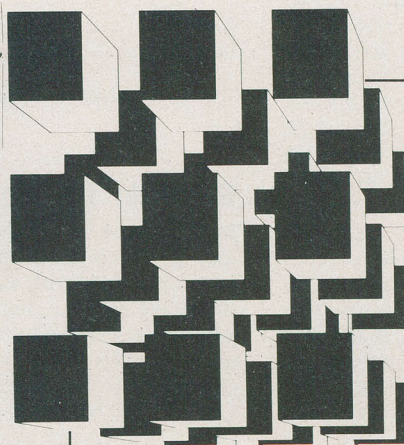
- Handheld 7-function, 35 ranges with 200 uA AC and DC. Hi-low ohms diode check.
- Built-in transistor test function.
- Overload protection. 2 amp fuse protects all meter ranges.
- Safety designed input jacks and test leads, tilt stand for bench use. Easy external battery access.
- Calibration certificate traceable to NRC supplied with meter.
- 1 year parts/labor guarantee.

SEE IT, TEST IT, COMPARE IT!

### BRUNELLE INSTRUMENTS INC.

826 Belvedere St., Sherbrooke,  
Quebec, J1H 4B8  
1-819-569-1335 Telex 05-836266

Mail Orders accepted: Send certified cheque  
or money order. Quebec residents add  
9% P.S.T. add \$3.00 for shipping.



**BICC vero**

**GET YOUR CIRCUIT CONSTRUCTION IN ORDER  
...BACK YOUR COMPONENTS UP WITH A  
VEROBOARD!**

This world famous board is still the fastest, easiest method of assembling electronic circuits.

It is available with a hole matrix of 0.1". It is worth remembering that 0.1" Veroboard contains 100 holes per square inch; imagine drilling those yourself. Write for your free catalogue of boards, components and tools including step-by-step instructions.



**Electronic Packaging Systems Ltd.**  
P.O. BOX 481, KINGSTON, ONTARIO, K7L 4W5  
PHONE (613) 384-1142 TELEX 066-3243  
Circle No. 4 on Reader Service Card.

Circle No. 17 on Reader Service Card.



The outputs of the ROMs to the data bus are *tri-state* outputs. That is to say, they normally present a very high impedance; they are virtually disconnected from the bus, and they are incapable of either sending or receiving signals. Each ROM has one (more in some types) special input known as *chip select* ( $\overline{CS}$ ). The bar over the  $\overline{CS}$  indicates that this is an active-low input. When the  $\overline{CS}$  input is made low, data outputs go to a low-impedance state and whatever data is present on the set of cells currently being addressed is put on to the data bus. Fig. 1 shows how we control which ROM is to be active at any given time.

## Go Low To Go

The function of the circuit is to enable one ROM at a time by making its  $\overline{CS}$  input go low. The ROM to be selected is determined by the signals present on the upper four address lines and on a control line which indicates when the MPU is ready to read data. In the Z80 this is the  $\overline{MREQ}$  line, which is active-low. The 74LS138 is a 3-to-8-line decoder which is typical of the ICs used for decoding address lines in computers.

Lines A12, A13 and A14 go to the A, B, and C inputs of this IC. Their states are treated as a three-bit binary input. Outputs Y0 to Y7 are normally high, but provided that the IC is enabled, one of the outputs is low at any one time, depending on the binary input to A,B,C. Thus when A is low, B is high and C is low, this corresponds to 010 (equivalent to decimal 2), and output Y2 goes low. This makes the  $\overline{CS}$  input of ROM2 low, so ROM2 is enabled while the other ROMs remain disabled in the high-impedance state. The location in ROM2 which is to be addressed is then determined by the state of the other lines (A11 to A0) of the address bus.

The decoding of inputs A, B and C as described above, takes place only if the decoder itself is enabled. It has three enable inputs, G1, G2A and G2B. To enable the chip, G1 must be high and either G2A or G2B must be low. You will notice the convention on the drawing that small circles are drawn at G2A and G2B to indicate that they are active low. The outputs also have these circles, for the same reason.

There are several possible ways of using the enable inputs to make sure that the chip is enabled only when address line A15 is low and the  $\overline{MREQ}$  line is low too. The solution shown here is to NOR A15 and  $\overline{MREQ}$  together and feed the result to G1. This makes G1 high only if both A15 and  $\overline{MREQ}$  are low. Inputs G2A and G2B are not used and are grounded.

Let us sum up the procedure of reading from ROM. In order to address any particular cell of ROM, the MPU puts its address on the bus. In the example

given, the address will be received along lines A0 to A11 in all three ROMs. The states of lines A12 to A14 are to be decoded by the 74LS138 and line A15 must be low to allow the decoder to be enabled. Then the MPU takes its  $\overline{MREQ}$  output low to indicate that it wishes to read data. This makes the NOR gate output go low, enabling the decoder. One of its outputs then goes low, enabling one of the ROMs. The ROM so addressed puts the data on the bus and this is read by the MPU.

The procedure outlined above must be carried out according to a strict time schedule. For instance, if the decoder acts too slowly, the MPU may be trying to read data before it is there. Some mention of this problem was made in Part 1, and we shall discuss it again in connection with RAM, next month.

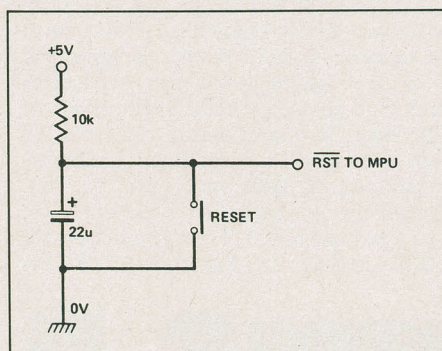


Fig. 2. A simple resetting circuit.

## ROM At The Top?

Readers who have taken the trouble to look at the circuit diagram of a computer and compare it with Fig. 4 may find that the ROM of their computer does not appear to be decoded to the low addresses in memory. This is the case if the computer concerned is based on the 6502 MPU. Unlike the Z80 and several other MPUs, the 6502 does not begin reading its program at 0000 after being reset. The 6502 has the special feature of *zero-page addressing*; this means that addresses in the range 0000 to 00FF can be addressed by using the lower byte only (00 to FF). This greatly simplifies and shortens programs, making this area of memory a very useful place in which to store frequently referred-to variables and tables. To take advantage of this facility, this part of memory must be allocated to RAM. Consequently, it is better if ROM is located at the top end (higher addresses) of memory instead. When the 6502 is reset, it first reads the two bytes which are stored at FFFC and FFFD, addresses almost at the top of memory. It is essential to place ROM so that it covers these addresses.

Memory cells FFFC and FFFD in ROM contain the two bytes which are the

address of the beginning of the monitor program. In the Apple II with the Autostart ROM, for example, these bytes are 62 and FA, respectively. The 6502, having read these two bytes, sets its program counter to the address they indicate (FA62 in this example) and then goes to that address to begin reading and executing the monitor program.

## Integrating ICs

Nowadays there is a move toward reducing the number of ICs required in computer systems. This is particularly important for special-purpose computers that are to be used in control applications, such as those in washing machines or video-recorders. The program required may be relatively small (perhaps only 2K or 3K) so there is no reason why the ROM should not be accommodated on the same slice of silicon as the MPU. If we have ROM, why not have RAM as well, and any other useful devices such as input/output ports and timers? A good example of this approach is the Zilog Z8 'computer-on-a-chip'; a similar device is the Mostek MK3870. The Z8 not only has an MPU but also 2K of ROM, 128 bytes of RAM (enough to use as a 'scratch-pad' to hold temporary data), four eight-bit I/O ports, two counter/timers, and an asynchronous serial interface. The ROM in the Z8 has to be mask-programmed, so this IC is not one that the hobbyist is likely to be using. The professional can obtain a version of the Z8 or the MK3870 with an EPROM mounted on it in piggy-back style. This can be programmed during the course of development and after all has been settled, the final program can be mask-programmed into the internal ROM of the production version.

A special version of the Z8, known as the Z8671, has the ROM pre-programmed with a Tiny BASIC interpreter as well as its monitor program. This can be used as the basis of a simple computer system. It has 144 bytes of RAM for use as a scratch-pad, but it can address up to 124K bytes of external RAM or ROM for the storage of programs. This version with its general-purpose BASIC in ROM has a wider appeal than custom-programmed versions, so it can be manufactured in quantity. Prices are falling and already several development boards are on sale which feature this IC. The phrase 'chips with everything' can now be taken to mean 'chips with everything on them'!

Next month, RAM: Reading, 'Riting, but no 'Rithmetic.

ETI



### Viewing Hoods HZ47 \$12.00

For HM203, HM204, HM605, HM705, HM808, HM312, HM412, HM512, and HM812

### Scope Tester HZ60 \$63.75

The HZ60 provides a fast-rising ( $\leq 5\text{ns}$ ) switchable 1kHz/1MHz square-wave generator for checking wide-band measuring amplifier systems and for probe compensation. Three BNC-outputs provide signals of  $20\text{mV}_{\text{pp}}$ ,  $0.2\text{V}_{\text{pp}}$  and  $2\text{V}_{\text{pp}} \pm 1\%$ .

### 4-Channel Switch HZ64 \$585.00

Enables the simultaneous display of 4 individual signals or 2 sums or 2 differences of signal voltages on an oscilloscope. Channel switching can be selected for chopped or alternate mode. Each channel comprises a 12-step frequency-compensated input attenuator with  $1\text{M}\Omega$  ||  $30\text{pF}$  input impedance. Sensitivity range  $5\text{mV} - 20\text{V}/\text{div}$  in 1-2-5 sequence. Bandwidth  $4\times\text{DC}-60\text{MHz}$ . Triggering (DC —  $100\text{MHz}$ ) is possible for each channel.

As an additional advantage, the input sensitivity of the oscilloscope can be increased by the 10x gain of the HZ64.

### Component Tester HZ65 SPECIAL \$60.00

Indispensable for trouble-shooting in electronic circuits. Single component and in-circuit tests are both possible. The HZ65 operates with all scopes, which can be switched to X-Y operation (ext. horizontal deflection). Non-destructive tests can be carried out on almost all semiconductors, resistors, capacitors, and coils. Two sockets provide for quick testing of the 3 junction areas in any small power transistor. Other components are connected by using 2 banana jacks. Test leads supplied.

### Examples of Test Displays:

Short circuit    Capacitor  $33\mu\text{F}$     Junction E-C    Z-diode  $<8\text{V}$



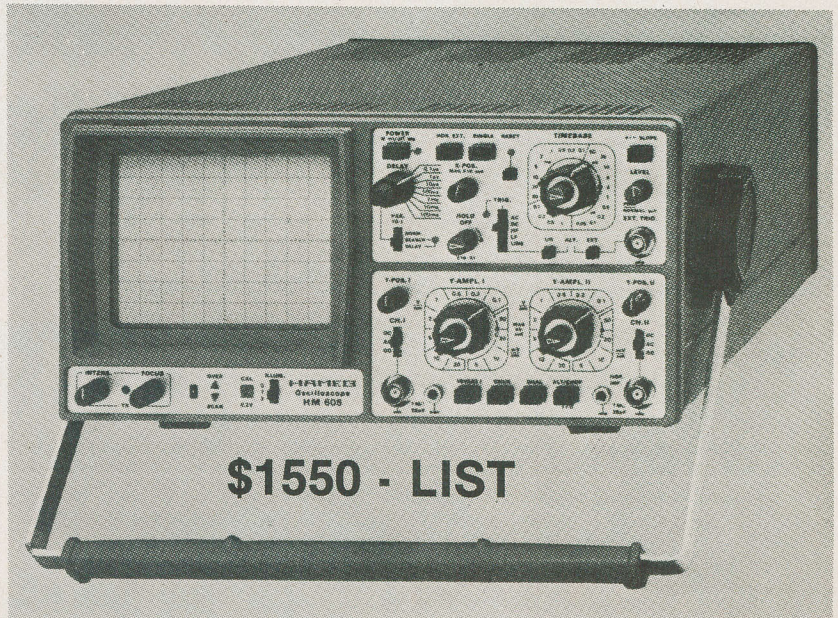
### Carrying Cases

For HM203-1 and HM203-3	HZ42	\$66.00
For HM312, HM412, HM512, and HM705	HZ43	\$48.00
For HM307, HZ62, and HZ64	HZ44	\$39.00
For HM103	HZ45	\$39.00
For HM204-4, HM204, and HM605	HZ46	\$73.50

All prices are List. To order, send Certified Cheque or Money Order. Minimum order for post or C.O.D. is \$25.00. All shipments are F.O.B. Downsview. Orders shipped within Ontario must include 7% Provincial Sales Tax. We accept VISA. Send card number, signature, expiry date along with name of bank.



Prices subject to change.



The **multitude of operating modes** of the **HM605** make it a universal oscilloscope — one which satisfies a wide variety of **laboratory demands**. Its expanded Y-axis sensitivity of **1mV/cm** allows extremely small signals to be displayed. Despite this high sensitivity, vertical amplifier drift is extremely low. Vertical overscanning of the usable screen area is indicated by LEDs. A built-in **delay line** permits **viewing** of the **trigger leading edge**.

**Triggering** is possible up to at least **80MHz**. Triggering facilities allow, among other things, the display of two **non-time-related signals**. Line triggering, single sweep, and variable hold-off time are also available. A sweep range of from **5ns/cm to 2.5sec/cm** ensures **high resolution** as well as display of extremely slow signals. Analysis of small signal sections of a waveform is possible using the **sweep delay** feature, which allows **X-expansion by 1000** or more.

A rectangular **14kV CRT** with an illuminated graticule provides exceptionally **bright, sharp displays**. The HM605 incorporates a switchable **fast-rise-time 1kHz/1MHz square wave generator** for high frequency probe compensation and system checks — a **unique feature** for scopes in this price range. This feature makes it possible to check transmission performance of the Y-amplifier, **compensation** of modular attenuation probes and optimum utilization of the entire bandwidth of the **instrument and probes**.

As with all new HAMEG flat-line oscilloscopes, a **component tester** is also incorporated in the **HM605**. The **outstanding price/performance ratio** of this oscilloscope is not likely to be matched by the competition in the near future.



980 Alness St. Unit 7,  
Downsview, Ontario.  
M3J 2S2  
(416) 661-5585  
TELEX 065-28169



# Product Review

## Brother EP20 Electronic Typewriter



**Computer technology is adapted to the typewriter in this tiny but versatile unit.**

**By Bill Markwick**

THE BROTHER Company, well-known for its larger typewriters, has had the portable EP20 on the market for a bit less than one year. Its price of just under \$300 aims it at the low-end portable market, but its unique features put it in a class by itself.

The first thing you'll notice about the EP20 is its tiny size (315 x 237 x 44 mm) which allows it to fit into a briefcase, and the second is that it has a full-size QWERTY keyboard that sits comfortably under the fingers for touch-typing. The keyboard has all the functions of a larger typewriter: tabs, margins, backspace and so forth, and also a second shift key which allows 44 special characters, such as foreign language accents and math symbols.

### Getting acquainted

Power it up using the supplied AC adaptor, or four D-cells, and insert the paper. Press the paper-feed button, and the

platen winds it in for you; there's the usual paper release lever for adjustments. You now have three options via a slide-switch: You can type directly to the paper, as you'd expect, or you can use the 16-character correction buffer before printout, or you can just use the buffer for practice typing without printing. Select the correction mode, which is the one you'll probably be using the most, and begin. As you type, the characters march past in the little window above the keyboard. If you should change your mind before typing 16 characters, there are control keys for moving the little cursor to insert and delete characters. When you've typed in the full 16, the miniature print head begins to print out the first keystrokes that you entered. Towards the end of the line the entire buffer is printed and a little motor whirs the print head back for another go. You soon get used to the fact that the keyboard is 16 characters ahead of the printer,

and you'll soon be catching all your mistakes before they reach the paper.

The print head holds the little ribbon cassette. It uses a plastic film ribbon, and this film is responsible for the very high readability of the printout from the 5 x 7 matrix. Unfortunately, it can't be rewound (all the carbon is transferred to the paper) and being so tiny, the number of pages you can get from one cassette is about twelve or so.

The impression you'll be left with from typing away is the remarkable smoothness and silence of the EP20. There's only a slight ticking noise as it prints out, and only a gentle whir as the head returns to the left. Try putting in accents: type the one you want and the cursor will wait until you type the letter under the accent. Beautiful! The only drawback is that a 5 x 7 matrix can't do proper descenders, the part of the letter that pokes down below the baseline; letters such



# Sord M-5 Review

**Like programming video games? Hate writing assembler code? Have lots of money to throw around? Anthony DeBoer looks at the computer for you.**



ONCE UPON A time, there was but one computer. It was lonely. Some time after this, however, there were many computers to keep it company, so many, in fact, that they had to be cloned to keep up with demand. Shortly after this, the Sord M-5 arrived on the scene.

Opening the box in which an M-5 arrives, you find a cute little computer, about the size of a good book (or a pair of paperbacks), nicely done up in two shades of grey and one of yellow. Examining it more closely, you find it has those eraserhead keys we've all come to know and love, a space key instead of a space bar, and an external power supply. The joysticks (the manufacturer calls them joypads) are the flat pad variety that are rather cumbersome to use. The intrepid user soon finds that the top back half of the machine's cover lifts off to reveal, yes, a cartridge slot. In other words, it looks much like your basic modern, mass-produced microcomputer.

Before we throw it in the corner with all the others of its ilk, let's give it half a chance and turn it on. It is, in fact, not until you turn it on that the M-5 shows any redeeming features at all. This machine has an extremely fast, compact BASIC that enables one to write decent video games without having to use machine code at all.

For \$460, the purveyors of this machine are willing to part with not only the machine itself, but also a pair of joypads, a BASIC-G cartridge, a case, and whatever other trivia is considered needful. This is rather steep for such a small machine, but on the other hand, the price might eventually come down.

## Eraserheads

The keyboard is the standard QWERTY arrangement, with one major exception: the space bar is missing. One finds, all the way to the right, just under the return key, a key marked SPACE. One does get used



# NEW

Apple™ II  
&  
Compatible

1,199  
WITH GREEN  
MONITOR



Tilt and Swivel Stand

- MPF III**
- 64K DYNAMIC RAM** A full 64K of random access memory provides the power you need to store a wealth of data or run sophisticated programs. 20K of ROM is expandable to 24K to suit customer applications.
- 80 COLUMN VIDEO DISPLAY** The standard 80 column display is double that of most personal computers. Upper and lower case characters can be simultaneously displayed. The display also features a screen editor with the capabilities to insert, delete, or clear the screen.
- 90 KEY ULTRASLIM DETACHABLE KEYBOARD** Besides the conventional 56 main key layout, the MPF-III comes with a numeric keypad, special function keys and user function keys.
- 36 TONE SOUND GENERATION CHIP** The MPF-III has a 36 tone sound generation chip that can be programmed according to your musical tastes. Sounds emitted include piano, bell, gunfire, bombing or laser.
- 7 INTERFACES FOR A WIDE ARRAY OF I/O DEVICES** The MPF-III has a standard 7 interface port configuration that gives you the ability to interface with disk drive, printer, cassette recorder, Z-80 CP/M card, Chinese character card and monitor or television.
- 3 EXPANSION PORTS FOR EASY EXPANDABILITY** Designed with user flexibility in mind, the MPF-III offers 3 expansion slots for special user application.

## "MVM-12 12" Monochrome Video Monitor

Green \$209.00  
Amber \$239.00

- \* HIGH RESOLUTION 12" NON-GLARE SCREEN
- \* P31 GREEN OR C134 AMBER SCREEN
- \* NTSC COMPOSITE VIDEO INPUT INTERFACE
- \* ERGONOMIC DESIGN WITH FULL TILT AND SWIVEL CAPABILITIES
- \* COMPATIBLE WITH MOST POPULAR MICROS

- \* VIDEO BANDWIDTH OF 18 MHz
- \* RESOLUTION OF 1000 LINES CENTRE, MINIMUM 800 LINES CORNER
- \* SCANNING FREQUENCY OF 15750 Hz HORIZONTALLY, 55 Hz VERTICALLY
- \* 120 DAY WARRANTY

## MULTITECH SLIMLINE DISK DRIVE

The Slimmer is a half-height 5¼" thin floppy disk drive that is compatible with some of the most popular computers on the market today, including the Apple II.

- \* Cost effective on-line storage
- \* 143K byte storage
- \* 35 track compatible

- \* Super slim profile
- \* Fast positioning time
- \* High reliability

- \* Safe media protection

**\$319.00**

535 QUEEN ST., W., TORONTO, ONTARIO, CANADA, M5V-2B4 (416) 864-0332



# MC MICRO COMPUTECH ELECTRONICS LTD.

## BASE — 64A

- \* **CPU:** 6502 1MHz, Z-80 A exchangeable (optional).
- \* **MEMORY:** System memory (ROM): 32K Byte. 4K Byte for monitor, 18K Byte extend basic language, (including function graphics, musics, self test, . . . etc.). 10K Byte miniwriter for wordprocessor. User's memory (RAM): 64K Byte can be expanded to 192K Byte by expansion card.
- \* **KEYBOARD:** 72 typewriter-style ASCII keyboard with numerical keypad, 27 one key command, 51 extra function key. High reliability keyswitch, at least 10 million strokes guarantee.
- \* **SYSTEM CONTROL:** Disassembler. Automatic Input/Output device assignment. Keyboard and screen editing feature. Register examine/modify and read/write cassette routine. Hex add/subtract for relative branch calculations.
- \* **INPUT and OUTPUT:** Typewriter-style ASCII keyboard. Cassette interface (1500 bps). 7 peripheral board connectors fully buffered, with interrupt and DMA priority structure. Game I/O: four analog to digital inputs, three TTL inputs and four TTL outputs. \* **COMPATIBLE:** with more than 10,000 Apple II™ application software.

**\$749**

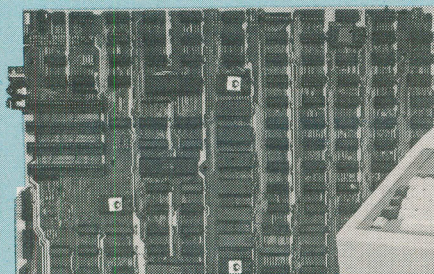
**MANUAL INCLUDED.**



## STAR 64 BRUTE

- \*Dual microprocessors 6502 & Z-80A \*RS-232 built in \*Disk drive interface card built in
- \*40/80 column text display and auto change video output port by soft switch \*76K RAM with 4 expansion slots \*16K ROM \*DOS 3.2 & DOS 3.3 capability \*Apple & CP/M compatible
- \*ASCII keyboard with function keys and a numeric keypad \*Upper/lower case \*Streamline case \*Heavy duty power supply \*OS could be changed when desired with- out affecting other memory RAM

**Distributed by Micro Computech  
Dealer Inquiries Invited**



## ATI FDD-810

**\$309 with controller \$369**

The "FDD-810" minifloppy disk drive is a high performance and economical mini type disk drive which is specially designed for APPLE II™ personal computer. SLIM TYPE DISK DRIVE IS 1/2 THE HEIGHT OF CONVENTIONAL MINIFLOPPY DISK DRIVES. HALF TRACKING ABILITY — AUTO EJECT — FULLY COMPATIBLE WITH APPLE II™ — USES STANDARD 5 1/4" DISKETTE — HIGH-RELIABILITY, LOW NOISE DC MOTORS PROVIDE AN MTBF OF OVER 8,000 HOURS, BACKED BY A 120 DAY PARTS AND LABOUR WARRANTY. **ATI FDD-820 SLIMLINE DISC DRIVE** \* ZERO SENSOR ABILITY \* Boots up immediately without any sound. ATI DISC DRIVES are distributed by Micro Computech and are now available at your local dealer.

## COPAM PC301

The COPAM PC301 is a 16-bit computer system designed specifically to be compatible with the popular IBM personal computer. The COPAM computer consists of system unit, 2 disk drives and keyboard.

**SYSTEM UNIT:** 16-bit computer • RAM 128K expandable to 256K • Multi function card — 2 channels serial asynchronous communications port (RS232 interface) — one parallel printer port — calendar/clock function, powered by rechargeable battery • Disc controller card handles up to 4 disc drives • Colour display card • Text mode 40 col x 25 row, 80 col x 25 row • Graphic mode 320 dots x 200 lines, 640 dots x 200 lines • High wattage power supply • Five expansion slots.

**KEYBOARD:** Fully detachable keyboard, function compatibility with IBM PC keyboard • Transmit serial 1/p • 95 keys • 10 Function keys • 15 numerical keys • 57 Alpha/num keys • 8 cursor control • 5 other keys.

**DISK DRIVE:** The PC301 comes with 2-5 1/4" double-sided, double density disk drives • unformatted - media 500K bytes track 6520 bytes • Formatted (16 sector, IBM format) media 327K bytes, track 4096 bytes.

**OPERATING SYSTEM:** Provides you with microsoft MS DOS, allowing purchase of prewritten and designing of software packages. MS DOS 2.0 & 1.1 can run on COPAM PC301.



**Call for more information & Pricing**

**PERIPHERAL CARDS, PRINTERS, MONITORS & MODEMS AVAILABLE ... CALL FOR BEST PRICES.**

**Introducing ADAM... The ColecoVision™ Family Computer System.™**

**DEALER INQUIRIES INVITED**

**MAIL ORDERS**

Send a certified cheque or money order (do not send cash). Minimum order is \$10. ADD minimum 5% for shipping cost. ANY EXCESS WILL BE CREDITED. Ontario residents add 7% provincial sales tax. VISA and MASTERCARD accepted. Send Card No. signature expiry date and name of bank.

**535 QUEEN ST., W., TORONTO, ONTARIO, CANADA, M5V-2B4 (416) 864-0332**

**ALL PRICES ARE IN CANADIAN FUNDS, 9% FEDERAL SALES TAX INCLUDED**

Circle No. 19 on Reader Service Card.



to this after a while, but it's a problem at first. The keys themselves are of the dark grey rubber pencil-eraser variety, each being square (or in some cases rectangular), with the lower right-hand corner cut off (except for the keys all the way on the right side, for which it's the lower left-hand corner). The keyboard is quite usable, although it's not exactly the expensive professional variety you would expect at the price given.

In addition to the usual SHIFT and CTRL keys, you get a FUNC key, which allows access to a number of keywords. FUNC-A, for example, causes the word "AUTO" to appear, just as if you had typed the whole thing yourself. There are also three modes: normal lower case, capitals, and graphics, this last allowing you to type in the graphics symbols that appear in yellow on the key caps.

Screen editing is also provided. You can move up to an offending line with the cursor arrows, delete things, insert things, and then hit return to re-enter the line. You soon discover that whenever you hit return, BASIC tries to act on the line you were on, regardless of what it consists of. This is an advantage, in that you don't need to copy over an entire line to change it, but can also be a disadvantage since it makes it impossible to splice bits of different lines together. It can also provide the occasional shock if you hit return over a line consisting of the word "NEW".

### Plug-ins

With the review machine came five cartridges: two BASIC's, two games, and a spreadsheet program.

The first BASIC, BASIC-I (meaning "Introductory"), seemed to be just a simple beginner's version of the other, BASIC-G (which stands for your choice of "Graphics" or "Games"). BASIC-I is a fairly decent BASIC, as such things go, but you need BASIC-G to get at all the capabilities of the machine, which is what the proud owner of an M-5 will naturally want to do. As far as we could tell, anything you could do in BASIC-I could be done just as well, if not better, in BASIC-G.

The two games, "Tank Battalion" and "Step Up" (a Donkey Kong variant), were mildly entertaining, but not as good as they could have been with real joysticks. The FALC spreadsheet was functional if somewhat unwieldy.

Turning the machine around, you find other connectors. There are two DIN plugs, for the power and cassette interface, a 16-pin connector marked "PRINTER", two joystick connectors, and RCA jacks for sound, video, and RF. Around the corner is a mysterious little switch, marked "H" and "L", that the manual doesn't mention.

Internally, the machine has a Z-80A processor running at the nice even speed

of 3.579545 MHz. Well, why use two crystals when one will do? There's nothing wrong with letting the whole machine run at the speed of its video output. Some internal firmware is included, containing standard stuff that most, if not all, cartridges would need, and at least one custom chip.

### Basically BASIC

BASIC-G is a fairly powerful BASIC with lots of features. Among the most notable are sprites and interrupts. (More on these later). The BASIC is quite easy to use, especially once you get used to all the nice little features (the editing and so on).

This BASIC is of the integer-only persuasion, which is good for its intended purpose of playing games, where speed is everything, or almost everything, but decidedly bad if you want to do scientific calculations or anything involving floating-point numbers. The BASIC-G manual mentions something called BASIC-F, which might be more useful here.

On power-up, the review machine claimed to have 7067 bytes free, although the technical literature mentions that 32K of external RAM can be added. This almost-8K is certainly enough for most simple BASIC programs.

One thing that you notice almost immediately is that this BASIC doesn't like it when you concatenate two keywords. You can't say "PRINTA" or "IFB=CTHENGOTO592". You have to put in the spaces and say "PRINT A" or "IF B=C THEN GOTO592". When you list your program, it will automatically insert all appropriate spaces for readability, lowercase BASIC keywords, and uppercase variables. Program listings look nice with this computer.

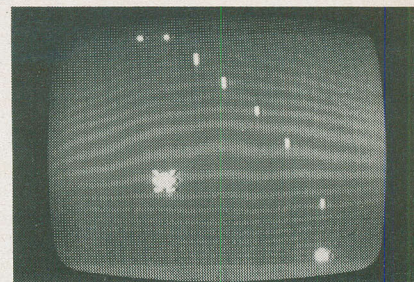
One bug with the program listings is that the LIST command, given a single line number (LIST 400, for example), will list from that line through to the end of the program. To list a single line, you have to type in LIST 400,400.

You can redefine the character fonts if you wish. The command STCHR "EF8485C58585F5" TO &45,1 will, for example, change the capital E to a miniature ETI logo. You can have lots of fun making the screen completely unreadable by changing all the characters. This pales after a while.

You eventually discover that a string variable cannot hold more than 18 characters. One supposes that this makes life easier for the BASIC, and you usually don't need more. The more elaborate applications that might need longer strings are generally done on larger machines with real keyboards and lots of disk space anyway.

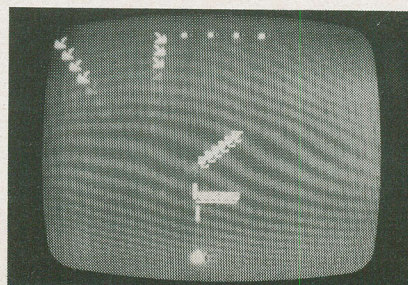
### Aliens

The M-5 can generate some extremely



Sprites used in a video game. The large alien is composed of four sprites, connected using the JOINT statement.

The alien is hit, and disintegrates in a most satisfactory manner. The individual sprites are clearly visible.





respectable graphics. No less than 32 sprites reside in the dark, if somewhat miniscule, interior of a TMS-9918A video display chip, along with the other workings for high-resolution colour pictures.

The BASIC-G software provides such tricks as drawing circles, boxes, bars (solid boxes), filling in areas (although the user is warned against filling in donut-shaped areas, since this can apparently result in an infinite loop), and the like.

The sprites are, however, the main feature of the graphics section. Individual sprites are little 8 by 8 bit beasts. The STCHR function is first used to redefine a convenient character in the alternate character set. One then uses the SCOD and SCOL statements to set a sprite to a character code and to colour the sprite respectively. The LOC statement can then be used to pop the sprite up onto the screen.

Moving sprites around is easy with this BASIC. You tell the machine to MOVE a given sprite either to a certain point or in a given direction, at a given speed. The machine then moves the sprite as directed. The BASIC program can then go off and do something else. Two important advantages arise from this fact, that a BASIC program does not need to move the sprites itself. First, the program is simpler. Secondly, and more importantly, the program executes more quickly, since the heavy work is done in machine code. This is probably the single most important feature in making BASIC video games run quickly.

You can join four small sprites into one big 16 x 16 bit sprite. You can also double the size of the sprites. You can thus create really large sprites that blow up very realistically (just like the rocks in Asteroids) when hit, by having the component sprites fly off in random directions. This can keep the kids thrilled for hours.

## 100 GOTO 100

One of the most notable features of the M-5 is its interrupt-driven BASIC. What, you may ask, is an interrupt? Well, an in-

terrupt is an event, either in software or hardware, that causes the computer to set aside whatever it's doing at the moment, go do something in response to that event, and then return to its original task. The M-5 provides six different interrupts: ERROR (whenever it hits a BASIC error), EVENT (a timer that can be set to provide an interrupt every second or so), ALARM (at a given time on the M-5's hours-and-minutes clock), COINC (two sprites colliding), JOY (any movement of the joypads), and KEY (any keyboard key, or the joystick fire buttons being depressed).

To use an interrupt, you give the computer a command like ON COINC GOSUB 1000, followed by COINC ON to enable the thing. Your program can then meander merrily along, happily flinging sprites across the screen at each other. Whenever two sprites manage to impale themselves on each other, the subroutine at line 1000 will be called. This routine can then sort out the debris. Add interrupt routines for EVENT (let the aliens change direction and drop bombs twice a second), JOY (so you can fly around), and KEY (so you can blaze away at them with your laser cannons), and you have a complete video game. The main part of the program simply sets everything up and then does nothing: 100 GOTO 100. Whenever anything happens, it wakes up, handles it, and goes back into its infinite loop.

Two complaints about the interrupt capabilities: First, on a COINC Interrupt, it is difficult to tell immediately exactly what hit what. There is a function, COINC(X), that tells you what, if anything, sprite X hit, but there should really be a better way. Second, there should be an interrupt on MOVE completed, such that you could then cause whatever had been moving to do something else.

These features, the sprites and the interrupts, make the BASIC ideal for programming games in. Your program provides only the control functions — what the screen should look like, what moves around and how, and what happens when things collide — and BASIC handles the real work in its machine code. The result, since so little is done at the speed (or lack thereof) of BASIC, is that games act as if they were written in assembler, without the associated programming headaches. You

can write decent video games without being a programming genius.

## Sounding Off

Also included in the M-5's internals is an SN76489AN sound generator chip. This can produce all kinds of weird and not so weird sounds. For example, the command PLAY "EAO6E" causes the first bar of "Lucy in the Sky with Diamonds" to be played. You can change the tempo, the volume, the type of sound, and so on. The PLAY command can be made to play harmonies, by giving it three things to play at once. Sharps, flats, triplets, octaves, dotted notes, rests, and staccato are included.

Should your musical tastes be less conventional, you can access the sound generator directly. There are four channels, three of which produce tones. The fourth produces noise (explosions, etc.). Everything needed to produce the sound effects for your video games is here.

On the other hand, a really high brow video game would be done completely without sound effects. To be technically accurate, it would have to reflect the reality that sound doesn't travel through the vacuum of space. Besides, it's really neat to be able to kill in silence.

## Moving Up

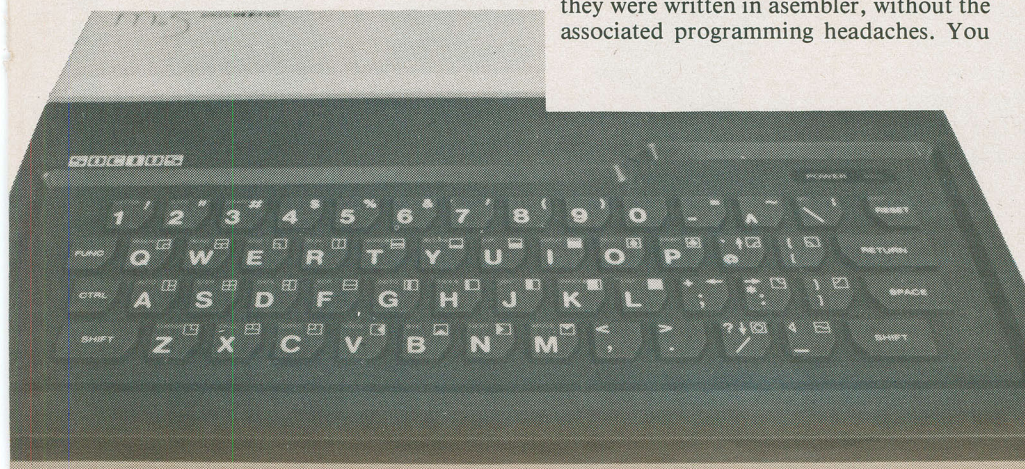
Beyond the games and graphics that the machine is so good at, there seems to be little room for expansion. One glaring omission that the experienced programmer will notice immediately is that there appears to be no provision for a disk interface. Such an interface might possibly be made through the cartridge connector, though. The technical manual mentions a serial interface that can be connected here, but absolutely no mention of a disk controller is made. Without disks, you can save programs only on cassette, which limits both what you can do and how eager you will be to do it. The FALC spreadsheet cartridge, for example, is rendered nearly useless by the lack of a disk.

A printer output is provided. Although we have not seen the printer that is supposed to go here, its capabilities supposedly include reproduction of graphics from the screen.

## Conclusions

The one thing that the M-5 does exceptionally well is to program games in BASIC. Its capabilities here make it an extremely worthwhile machine, if you're willing to pay the price. If, on the other hand, you're into serious data processing, and you want to save your programs on a disk at the end of the day, \$460 could go a long ways toward buying a clone. The Sord M-5 is a computer for people who want a cute little machine to have lots of fun with.

ETI

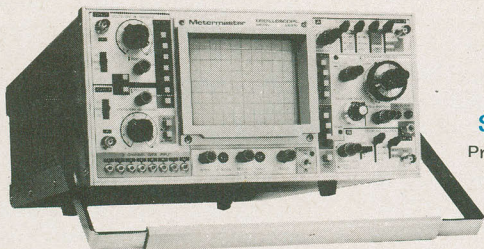




# OSCILLOSCOPES!

## The Best Buys Available

Model 65810  
100 MHz Bench/Portable Scope



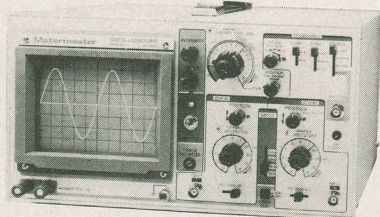
**\$ 2695.00**  
Probes & FST  
included

A HYBRID COMBINING ANALOG AND  
LOGIC FUNCTIONS

### VERSATILITY +

- Will Display 4 Analog Traces (independently adjustable) or 8 Logic Channels, or 3 Analog and 8 Logic
- 2ns/Div. Sweep Speed
- 16 kV CRT Potential for A Bright Clear Display
- Scale Illumination
- Delayed Triggered Sweep

Model 65601  
Dual Trace Bench/Portable Scope

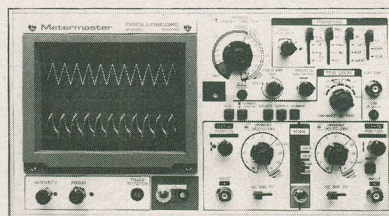


**\$ 795.00**  
Probes & FST  
included

Featuring at no extra cost . . . . . 'The Component Tester'

- 20 MHz (-3dB) Bandwidth
- Trace Rotator
- 6" CRT Display
- 2 mV Vertical Sensitivity
- Fully Automatic Triggering
- HF Rejection

Model 65635  
Dual Trace Bench/Portable Scope



**\$ 995.00**  
Probes & FST  
included

- 35 MHz (-3dB) Bandwidth
- Delayed Sweep (selectable)
- Single Sweep (selectable)
- 6" CRT Display
- 1 mV Optimal Sensitivity
- X-Y or X-Y-Z Operation
- 120V AC Line Operation
- x5 Sweep Magnifier

# MULTIMETERS!

## Go for Quality --- Go for The Best Value

Models 78020, 78021, 78022

- AUTO ZERO
- AUTO POLARITY
- 3½ DIGIT LCD
- FULL OVERLOAD PROTECTION ON ALL RANGES
- RECESSED - SAFETY DESIGNED INPUT TERMINALS

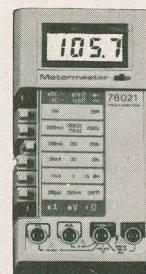
Supplied with:

- 28 Page Operating and Maintenance Manual
- Calibration Certificate Traceable to NRC
- Schematic with complete Parts Listing
- Safety Test Leads
- One-year Warranty



**\$ 159.00 \***

- ◆ ±0.1% DC
- ◆ 2000 hrs Bat. life



**\$ 120.00 \***

- ◆ ±0.25% DC
- ◆ 10 Amps AC+DC
- ◆ 200 hrs Bat. life



**\$ 99.00 \***

- ◆ ±0.25% DC
- ◆ 200 hrs Bat. life

\* F.S.T. extra

## Metermaster

A Div. of R.H. NICHOLS CO. LTD.

Head Office: 214 Dolomite Drive, Downsview, Ontario M3J 2P8

TORONTO (416) 661-3190 MONTREAL (514) 337-0425 EDMONTON (403) 432-7746 OTTAWA (613) 238-7707



5% Discount for Cash,  
Certified Cheque, or Money Order  
DEALER INQUIRIES INVITED

All prices F.O.B.  
Downsview, Ontario  
subject to change with-  
out notice. P.S.T. extra  
where applicable.



# Designer's Notebook

**Who needs to bother winding miles of wire onto a bobbin when high voltages can be generated with some inverters and a handful of diodes and capacitors? Rory Holmes shows how it's done.**

IN THIS MONTH'S Designer's Notebook we shall be looking at a variety of interesting voltage multiplier circuits that can be built using ordinary CMOS gates and common-or-garden 1N4148 signal diodes. DC-to-DC converters for a number of applications became possible by simply driving voltage multiplier chains with an AC clock signal, again implemented with CMOS gates. The initial supply voltage can be multiplied both positively and negatively to give, for example, a split rail op-amp supply from a standard 5 V TTI supply. Negative and positive voltage references used in analogue-to-digital conversion and other signal conditioning circuits can also be generated, as can general purpose high voltage bias rails.

By using a novel 'chain' of inverter gates to independently drive each node of a diode-capacitor ladder, some rather unique circuits result.

## Chain Reaction

First, let's look at the usual multiplier circuits shown in Fig. 1a. These are normally used with rectifier-type diodes, low frequency AC inputs (sine waves) from transformers, and electrolytic smoothing capacitors. At first glance there seems to be no common pattern between them, and little similarity to the multiplier chains used in TVs and other high voltage power supplies.

However, in all cases the AC input waveform is fed via capacitors to appear at those circuit junctions marked 'A' in Fig. 1a, while those junctions marked 'D' will maintain a steady DC potential relative to the ground point. We can thus redraw the circuits by connecting up the capacitors in two series chains (assuming their values are altered accordingly) and still preserve the same circuit action. One chain carries the AC signal, while the other accumulates the DC voltage shifts. Figure 1b shows these redrawn circuits, which now appear as extensions of the

standard ladder network. The doubler, of course, remains in its original form since it only has one set of capacitors.

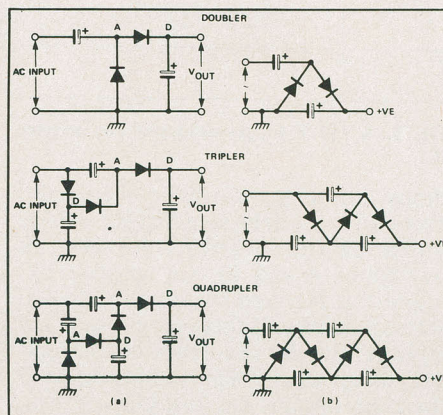


Fig. 1. Standard voltage multiplier circuits.

Starting with the doubler, we can build a very simple DC-to-DC converter in one CMOS gate as shown in Fig. 2. The Schmitt inverter gate is configured as a square wave oscillator running at about 100 kHz — the multiplier capacitors C2 and C3 will therefore have a low impedance at this frequency, which is also within the switching speed capability of the 1N4148s. For this reason, rectifier diodes such as the 1N4001, which have much slower switching speeds, cannot be used in these circuits.

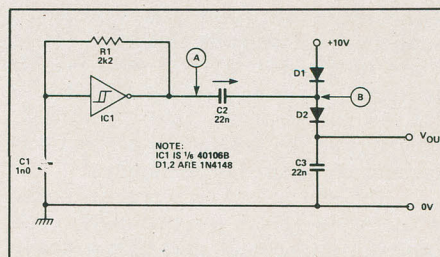


Fig. 2. A CMOS doubler circuit.

The oscillator output at point 'A' will therefore be switching between the 0 V and 10 V supply levels. When the output is at logic low, capacitor C2 will charge up positively (in the direction of the arrow) via D1. D2 is reverse biased and so effectively out of circuit. When point 'A' goes high to +10 V, the positive end of C2 at 'B' will be raised to +20 V. This reverse

biases D1 and allows C3 to charge up through D2. The voltage on C3 is thus maintained at about +20 V less two diode drops (i.e., at 18V6) as the cycle repeats itself. This is known as a diode charge pump.

## Building An Extension

This principle can be extended using exactly the same chainlike structure as illustrated in the positive and negative multipliers of Fig. 3. In both cases the inverter gates are cascaded and driven from a square wave oscillator at around 100 kHz. Each inverter gate contributes its own output current (a maximum of around 2 mA) via the capacitors into the multiplier chain; because of this, the available output current will always be the same no matter how many times the voltage is multiplied (two times in this case).

The positive multiplier output of Fig. 3a includes the initial positive supply potential, and so generates three times this voltage less the three diode drops of 0V7 each. The negative multiplier of Fig. 3b, on the other hand, is referenced to the ground rail, given -2 times the voltage (again less the diode drops).

As mentioned before, all the diodes are 1N4148s; the multiplier capacitors C2-4 are all non-critical and may be anything from 10nF to 100nF. C4 may be

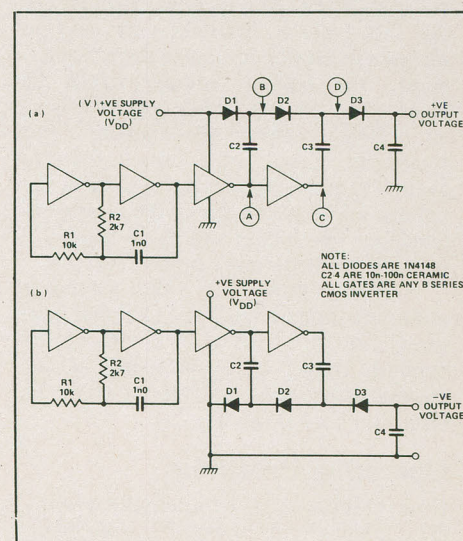


Fig. 3a. A two-stage positive voltage multiplier (multiplies by +3). b. A two-stage negative voltage multiplier (multiplies by -2).



## Designer's Notebook

a polarised tantalum capacitor of a few microfarads to provide further smoothing. Any type of CMOS gate which can be connected as an inverter could be used, as well as all the standard inverters, though the 4049B hex inverter offers slightly more output current. It's also possible to use the 74C series types such as the 74C04 or 74C14. Pin-outs for these chips are given in Fig. 4 and not on any of the circuit diagrams, since they differ from type to type.

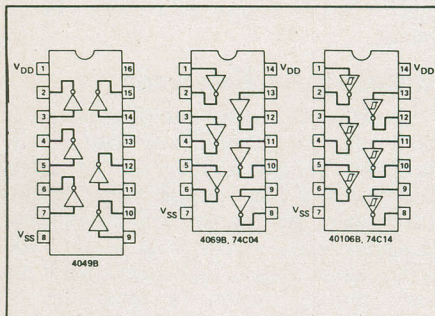


Fig. 4. Pin-outs for the standard hex inverter packages which may be used in the circuits given in this article.

The oscillator implementation and its frequency are also non-critical; you could experiment with anything from several kilohertz to several hundred kilohertz. Remember, though, that as the frequency decreases, the impedance for a given capacitor value will increase, so increasing the impedance of the multiplier output.

Table 1 lists out the different voltages you can expect from different chain lengths and supply voltages, based on the circuits of Fig. 3. The number of stages refers to the number of capacitors that are actively driven from inverter outputs. Using this table it becomes very easy to design a generator for any voltage requirement; the output voltage could be clamped to the exact level required using an ordinary zener diode regulator. But remember there isn't much current available, and as the output is loaded, the voltage will decrease due to the supply impedance. The higher supply voltages will generally provide more output current.

As an example, Fig. 5 shows a longer multiplier designed to give 110 V and built using only one hex inverter IC of the Schmitt trigger type (40106B). Using ceramic capacitors, this circuit could be built to a very small size.

## Operating Principles

How do these multipliers actually work — the doubler circuit of Fig. 2 is straightforward, but what about the longer types? Voltage multiplier explanations are usually notoriously difficult to follow, let alone understand, and we shall therefore adopt

a more graphic approach. If we measure the voltages at the lettered points in Fig. 3a and plot them against time, we get the waveforms shown in Fig. 6. These waveforms have been idealized for clarity — no account has been taken of the voltage

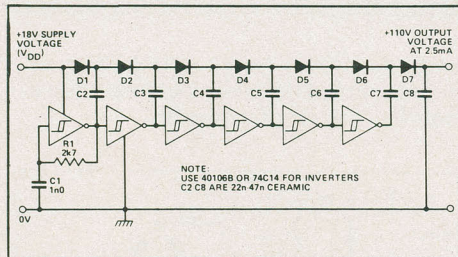


Fig. 5. A 110 V supply using one hex inverter IC.

drops due to the diodes in the circuit. From these it can be seen that the voltage across C2 (the difference between the waveforms A and B) is a constant 1V, where V is the supply voltage, while that across capacitor C3 (between points C and D) is 2V. We also know that the final output voltage across C4 is 3V. Moving down the chain towards the final output, then, we find that each capacitor maintains a DC charge which increases in integer multiples of the supply voltage. How so?

Consider capacitor C2 in Fig. 3a. At power-on it is discharged, but when point A switches low, it charges up to the supply voltage via D1 (neglecting diode drops). Point B is therefore at supply voltage. When point A switches high, then, point B is raised to twice the supply voltage. Point C must be at zero volts since it is the inverse of point A, so current flows via D2 (which is now forward biased) from point B into C3 until C3 is charged up to the voltage at B (i.e., twice supply). The next clock pulse takes point A low, so point B is at supply less the voltage that has leaked into C3, and C2 is topped up via D1 again. Meanwhile point C has switched to supply voltage, so point D is now at three times supply and D2 is reverse biased, preventing C3 from discharging back into C2. C3 can discharge into C4 via D3, however, so the voltage across C4 is maintained at three times supply.

It should now be clear that no matter what the length of the multiplier, each capacitor in the chain maintains a steady

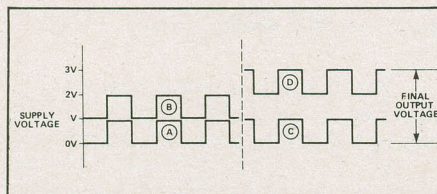


Fig. 6. Waveforms for a two-stage positive multiplier (idealized for clarity with diode drops ignored).

DC charge which equals that on the previous one plus the supply voltage, and each capacitor tops up the next one in the chain on each alternate half-cycle. Figure 7a, for example, shows five stages of a multiplier chain driven by a square wave signal, while Figs. 7b and 7c use a waveform to represent the voltage levels at each capacitor node for each half of the cycle. The direction and voltage of the DC charges on each capacitor is also shown — remember these are constant as shown by the graph of Fig. 6.

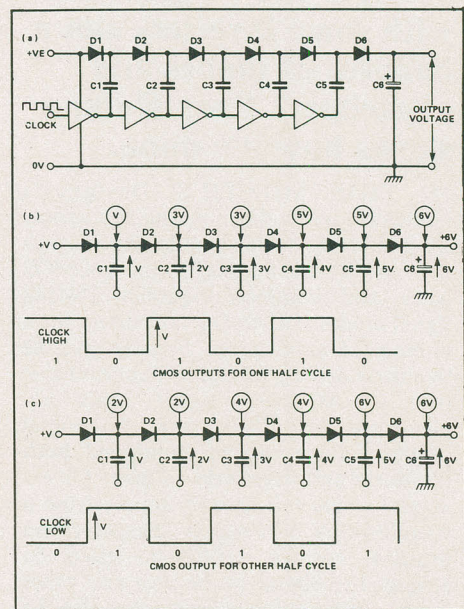


Fig. 7. How multiplier voltages accumulate down the chain.

Looking at C1 and C2 in Fig. 7b we can see that the positive (top) end of C1 will be at V volts (V is the supply voltage) while the positive end of C2 is at 3V volts (2V of its own, raised up a further V volts at the CMOS output). Diode D2 will therefore be reversed biased and effectively out of circuit. For similar reasons C3 will be at 3V volts (less that which has leaked away) and can therefore be charged up via D3 from C2. On the other half cycle in Fig. 7c, however, C3 will be raised up to 4V volts by the CMOS output, while C2 returns to 2V. So this time D3 is reverse biased and will not conduct. C1 is now raised to 2V and can thus charge C2 via D2. The conducting and non-conducting parts of the circuit for each half cycle are shown in Fig. 8, which gives a much clearer illustration of the diode charge pump action.

## The Appliance of Science

Figure 9 shows the circuit of a split-rail power supply that generates  $\pm 10V$  from a 5V supply input. It could be used to power

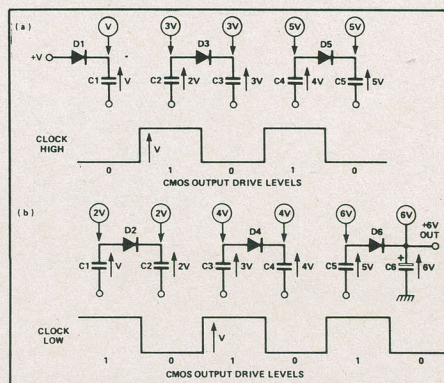


TABLE 1						
OUTPUT POLARITY NO. OF STAGES	CMOS SUPPLY VOLTAGE					
	5V		10V		18V	
	+	-	+	-	+	-
1	8.6	3.6	18.6	8.6	34.6	16.6
2	12.9	7.9	27.9	17.9	51.9	33.9
3	17.2	12.2	37.2	27.2	69.2	51.2
4	21.5	16.5	46.5	36.5	86.5	68.5
5	25.8	20.8	55.8	45.8	103.8	85.8
6	30.1	25.1	65.1	55.1	121.1	103.1
7	34.4	29.4	74.4	64.4	138.4	120.4

Table relating supply voltage and number of stages to the (unloaded) output voltage, for positive and negative output multipliers based on the circuits of Figs. 3a and 3b and allowing 0V7 for each diode drop.

low current op-amp circuitry and other CMOS circuits from a standard TTL power supply. Again, only one hex inverter pack is required and we recommend that the 4049B is used with its slightly higher output current capability. The circuit takes advantage of the three cascaded inverters that drive the positive multiplier chain, by also using them to form a 'ring-of-three' oscillator. The multiplier chain is therefore self-oscillating!

The positive side in turn drives the negative chain of IC1d,e and f. From Table 1 we would expect the available out-



put voltages to be +17V2 and -12V2, which are then clamped to the  $\pm 10$  V levels by zeners ZD1 and ZD2. Series limiting resistors for the zener diodes are unnecessary due to the current-limited output of the multiplier.

Fig. 8. Charging paths for an extended multiplier chain. The diagrams only show those diodes which are forward biased (conducting) during alternate half cycles of the drive waveform.

## NIELSEN NCI COMPUTERS INC.

**GET A BUNDLE — SAVE A BUNDLE ON COMPUTERS AND ACCESSORIES FROM NCI.**  
**APPLE™ & CP/M™ COMPATIBLE COMPUTER.**

NCI 9000B Computer. 48K, num. key, 27 function & 24 programmable keys .....\$595.00  
 Franklin Ace Propackage. 64K, 80 column, Acecalc, Acewriter, Disk Drive .....\$CALL  
 Ace 1200 office management system, two drives, 128K, CP/MTM card, 80 column, serial & parallel, Wordstar, Mailmerge, Acecall & more .....\$2995.00  
 Disk Drives — Shamrock full size .....\$319.00  
                   — ATI Slim .....\$329.00  
 Controller Card — NCI 900 .....\$59.95  
                   — Shamrock .....\$79.00  
 80 column — supports other languages & operating systems such as Pascal, BASIC, etc., Inv. character set & pre-boot software .....\$79.95  
 80/40 Column selector switch. Cable included .....\$7.95  
 Parallel Printer Card. Supports graphics, cable & manual included .....\$99.00  
 Pure Data PDA 232C serial card for printer & modems. Manual and cable included .....\$106.00  
 CP/MTM software & manual also available for the PDA card .....\$25.00  
 Direct Connect Smart Modem 300 baud. Plugs directly into your 6502 computer, auto answer & dial, fully approved .....\$289.00  
 R.G.B. Colour board to operate your R.G.B. colour monitor .....\$149.00  
 128K RAM Card. Instructions & software included .....\$295.00  
 16K RAM Card .....\$62.95

### JOYSTICKS

Hayes Mark III. Highly acclaimed .....\$69.95  
 Hayes Mark III. For Apple //e .....\$78.00  
 KL205 .....\$47.00  
 Kraft Paddles .....\$63.95

### MONITORS

Electrohome Colour ECM 1302-1 .....\$339.00  
 Electrohome Colour ECM 1302-2 .....\$449.00  
 Electrohome Colour ECM 1302-3 (IBMTM) .....\$495.00  
 12" Yan Jen Amber. Composite video .....\$198.00

### PRINTERS

Seikosha GP100 .....\$349.00  
 TTX1014 Daisywheel .....\$849.00

### KAYPRO COMPUTERS:

Kaypro II .....\$CALL  
 Kaypro IV .....\$CALL  
 Kaypro 10, 10 meg. hard disk, 360K floppy disk .....\$41.95

Wordstar now also included free with the standard series of software which comes with all the Kaypro computers.

### ATARI

New 600XL computer. 16K expandable .....\$249.00  
 New 600XL computer with 64K built in memory .....\$389.00  
 New 1050 Drive - cable included, direct connect .....\$599.00  
 Seikosha dot matrix printer with cable included, direct connect .....\$499.00  
 Games — Pole Position .....\$54.95  
                   — Donkey Kong .....\$54.95  
                   — Star Raiders .....\$54.95  
                   — Galaxian .....\$54.95  
 Joystick with 3 firing buttons, one on handle .....\$16.95  
 10' Joystick extension cord .....\$7.95

### SOFTWARE

Sound Computer  
 Payroll .....\$595.00  
 Bank St. Writer .....\$95.00  
 Visifile .....\$350.00  
 Acewriter .....\$209.00  
 Acecall .....\$209.00  
 Wizardry .....\$52.00  
 Lode Runner .....\$45.00  
 Zork .....\$51.00  
 Choplifter .....\$45.00  
 Aztek .....\$51.00



**NIELSEN COMPUTERS INC.**

275 Lancaster St. W. Kitchener, Ont. N2H 4V2  
 519-886-1282

MAIL ORDERS for small items add \$3.00 for shipping and handling. Ontario residents add 7% P.S.T. Sent certified cheque or money order. If paying by VISA or Mastercard, send card number, expiry date, bank, and signature.

Circle No. 10 on Reader Service Card.



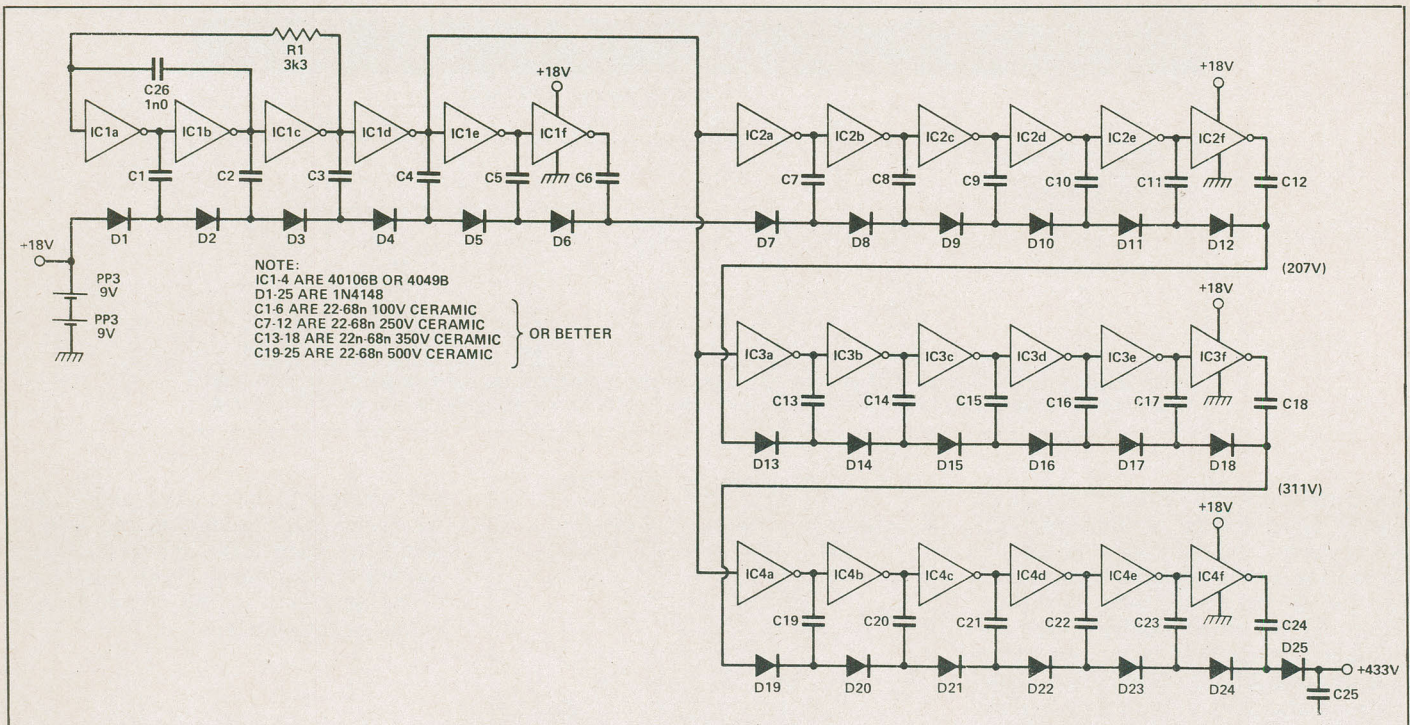


Fig. 11. A 433 V generator using a 24-stage positive multiplier and an 18 V supply.

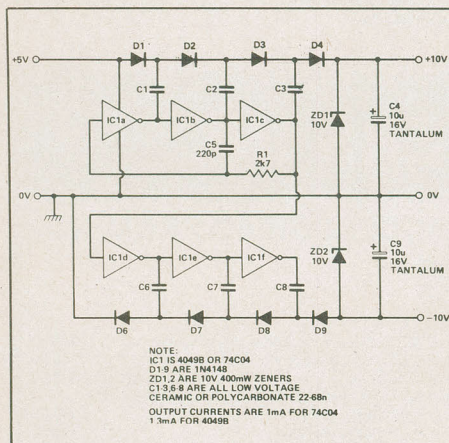


Fig. 9. A split-rail supply using one hex inverter package.

Figure 10 shows a variation on the previous circuit's positive multiplier section, using all six inverters to provide more output current at  $\pm 10$  V. To achieve higher output currents, simply parallel the CMOS gates that drive the capacitor chain; the available currents will add together due to the nature of the CMOS output FETs. This technique is useful for CMOS operating at low supply voltages.

Figure 11 gives the circuit for a 24-stage positive multiplier to generate a high-voltage, low-current supply. This could be used for a solid state 'megger' (high resistance meter and insulation

tester). The 24 stages can be achieved using only four hex inverter packs, and will provide 433 V from an 18 V supply. This circuit illustrates the fact that the inverters may be wired up in any fashion so long as alternate capacitors receive opposite phases of the square wave.

The circuit will deliver at least 2 mA at 430 V! — not lethal but pretty painful, so be careful. We suggest the addition of a 1M $\Omega$  series resistor in the positive supply lead to limit the available current to about 40  $\mu$ A. A 100  $\mu$ A meter would provide suitable megaohm readings.

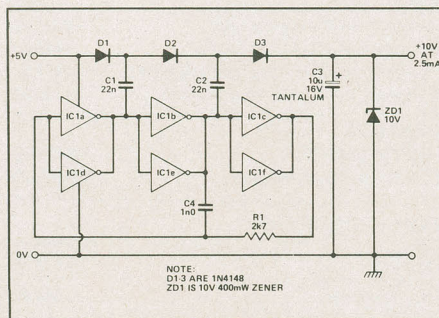


Fig. 10. Paralleling inverter stages to give a higher current supply.

## Arthritis Facts:

- More than three million Canadians have arthritis.
- More than 30,000 arthritis victims are under 15.
- Nearly one million arthritis victims are between 30 and 45.
- 200,000 arthritis victims in Canada suffer every day with long-term disabilities.

Arthritis is everybody's problem and it's time we took it seriously. Contact The Arthritis Society office nearest you for the facts about this terrible disease.



THE ARTHRITIS SOCIETY

ETI





## ZEUS-2001

- ★ 6502A CPU, 4-K Rom Self-test Routine
- ★ Powerful 64-K dynamic Ram Motherboard
- ★ 8 Expansion slots
- ★ 256 special function keys for Basic, Pascal, Fort & CP/M.
- ★ 16 bit address bus, 8 bit data/register
- ★ Full ASCII keyboard with 72 keys
- ★ Auto-repeat keys, PAUSE & BREAK keys
- ★ Oversize power supply with built-in fan
- ★ 96 printable ASCII characters
- ★ Heavy duty construction
- ★ This computer is capable of running most complex languages. Accepts plug-in modules, making it compatible with most popular operating systems such as CP/M, Fortran, Pascal, Fort, etc.

**SPECIAL INTRODUCTORY PRICE ...\$798.00**



Disk drive (slim, quiet operation)	\$348.00	Speech card	\$ 98.00
Disk controller (Auto stop, auto boot 13 or 16 sectors)	\$ 78.00	R.F. Modulator	\$ 28.00
16-K card	\$ 78.00	RS-232C card	\$ 88.00
Z-80 card	\$ 88.00	Graphic table	\$158.00
80 column card	\$ 88.00	Joy-stick (self-centre)	\$ 38.00
Graphic printer card	\$ 98.00	DELUXE Joy-stick (self-centering, adjustable, heavy duty metal case)	\$ 68.00
16-K Buffer card	\$108.00		
16-K Printer/buffer card	\$188.00	DYSAN DISKETTES	\$ 44.95

**(WE ARE ALSO SPECIALIZED IN COMPUTER & ELECTRONIC PARTS OF ALL KINDS)  
DEALERS REQUIRED. ALL ENQUIRIES ARE WELCOME  
CALL FOR QUANTITY PRICING.**

### MAIL ORDERS

Send certified cheque or money order (do not send cash) Add 5% for shipping. Quebec residents add 9% PST.

**ADDRESS FOR MAIL ORDERS:** J.M.T. Inc., 400 St-Jean, Longueuil, Quebec. J4H 2X6  
Tel.: (514) 674-8536 Telex: 055-61811 MGMSECT  
**SHOWROOM & PERSONAL SHOPPING:** (SERVICE CENTRE) MASTER VOX LTD.,  
400 St-Jean, Longueuil, Quebec. J4H 2X6 Tel.: (514) 670-1550

Circle No. 21 on Reader Service Card.

## HAMEG 70 MHz Oscilloscope

### Model HM705

Reg. \$1,750

**Special \$1,550**

Limited time offer.



The HM705 general purpose oscilloscope, with its many operating modes and triggering facilities, is designed for both laboratory and field use. Vertical amplifier performance and the high resolution of its timebase permit usable display of signals up to 100MHz. Even signals of only 5mm display height can be stably triggered at that frequency. With its built-in delay line, trigger leading edges of signals are made visible, providing a higher degree of time resolution. Individual sections of a signal waveform can be expanded by a factor of 1000 when using the sweep delay feature, and are limited only by the fastest sweep rate of 5 nsec/cm.

Modern technology is exemplified by all the features of this oscilloscope. The HM705 is an instrument of unusual flexibility equally applicable in all fields of communication, consumer, and industrial electronics.

**Authorized Franklin ACE dealer**

Mail orders accepted, send certified cheque or M/O. Add 5% for shipping. Ontario residents add 7% P.S.T.

★★★★

**general electronics**



5233 Yonge St., Willowdale, Ont.,  
M2N 5P8 (416) 221-6174.

• HAMEG SCOPES • PARTS, KITS • SURPLUS



Circle No. 16 on Reader Service Card.

# JLS

**can take you from  
Boards to Boardrooms with our  
new IBM PC compatibles**

ASSEMBLED and TESTED IN TORONTO

● OBM 100... \$495.00  
Mother Board using 8088 micro processor  
48K EPROM space / 5 expansion slots

● OBM 256... \$359.00  
256K RAM card  
64K on board / RS 232 port

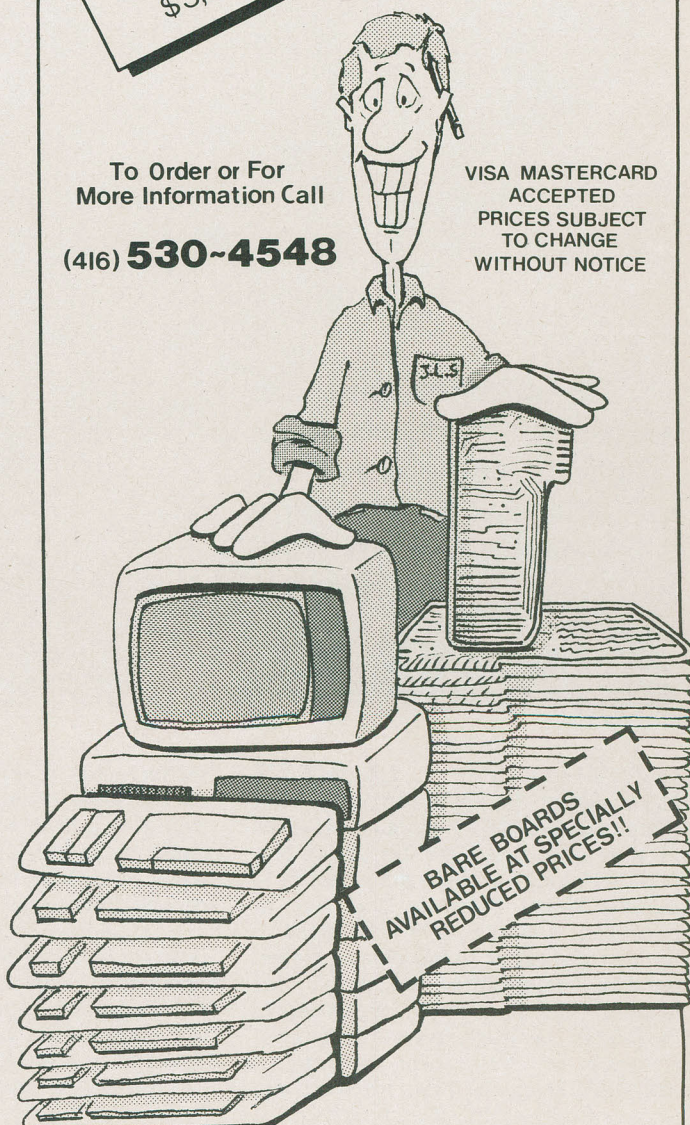
● OBM 400... \$289.00  
Disk Controller  
Drives 5 1/4" or 8"

Complete Systems  
Available Under  
\$3,000.00

To Order or For  
More Information Call

**(416) 530-4548**

VISA MASTERCARD  
ACCEPTED  
PRICES SUBJECT  
TO CHANGE  
WITHOUT NOTICE

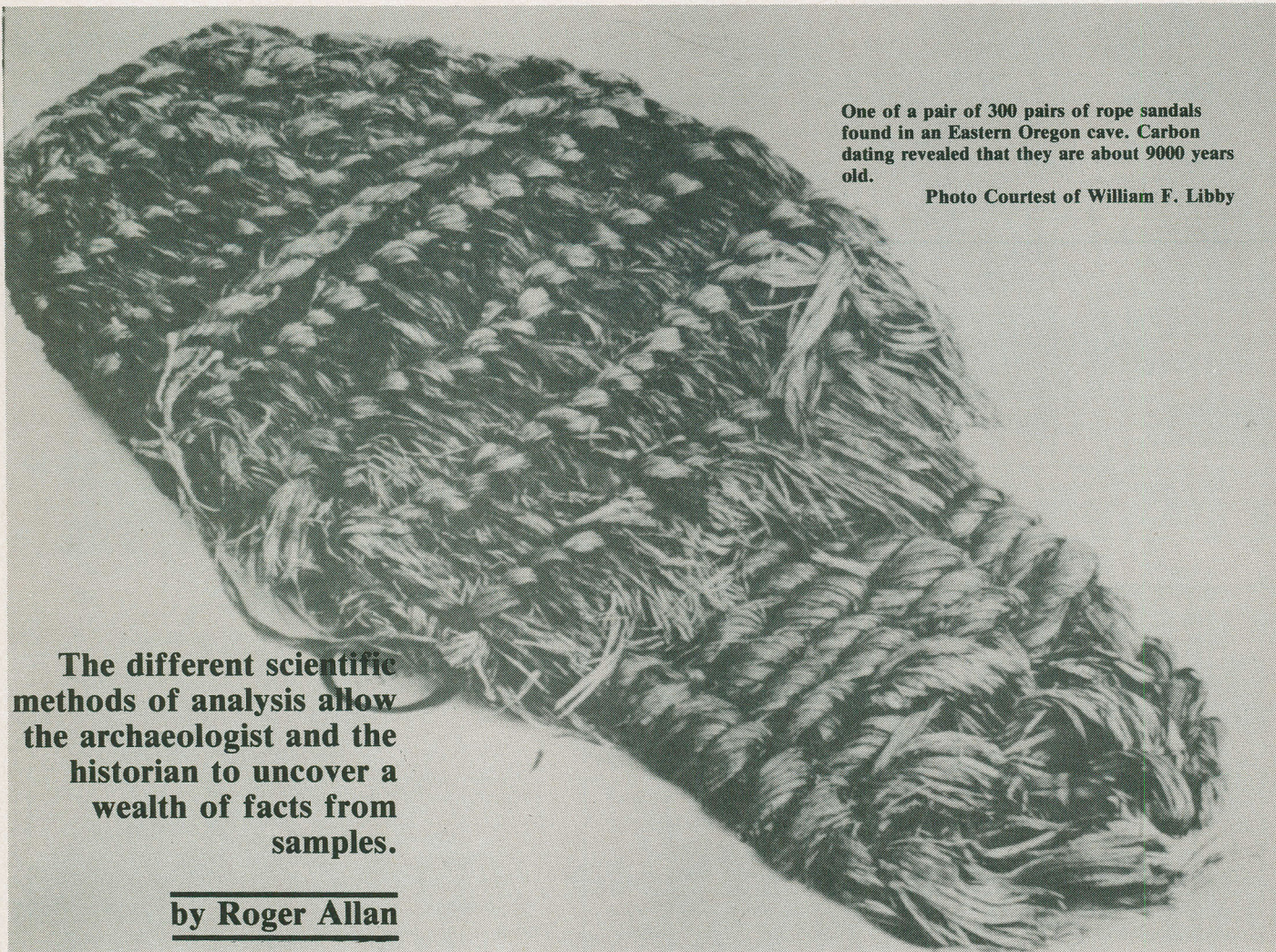


IBM, IBMPC is a trade mark of International Business Machines Can. Ltd.  
JLS Computers Inc. 67 Mowat Ave., Ste. 343, Toronto Ont. M6K 3E3

Circle No. 24 on Reader Service Card.



# Nuclear Applications in Archaeology



One of a pair of 300 pairs of rope sandals found in an Eastern Oregon cave. Carbon dating revealed that they are about 9000 years old.

Photo Courtesy of William F. Libby

**The different scientific methods of analysis allow the archaeologist and the historian to uncover a wealth of facts from samples.**

**by Roger Allan**

CUSTOMARILY, LAYMEN'S knowledge of the application of nuclear techniques to archaeology can be summed up with a single method: the dating process via Carbon-14. It is well known, earning the Nobel Prize in 1960, for its discoverer, Willard F. Libby. Its ripple effect on the study of Archaeology is incomparable, oftentimes related to the discovery of the periodicity of elements in the field of chemistry. But it is only one of a number of such nuclear applications, and while being the first, foremost and most generally useful of such techniques, cannot answer a number of questions about artifacts which Archaeologists need to know. It has its drawbacks. Its primary use is in the dating of wood and vegetable

matter, with increasing difficulty in use for the dating of bone, textiles, ivory and iron (iron can in some circumstances be dated using this method because iron from very old samples contains carbon derived from wood charcoal).

A quick overview of the theory and process: The earth is being constantly bombarded with cosmic radiation, one form of which is neutrons. These react with nitrogen in the upper atmosphere to produce carbon-14. The flux of such neutron bombardment has been constant throughout history, up until about 1900 when man commenced to disturb the natural environment and unbalanced the carbon-14 constancy of uptake. This carbon-14 reacts in the atmosphere to

form carbon dioxide. The carbon dioxide is taken up by all forms of vegetation, and hence into all life forms that eat vegetation. The amount of uptake ceases at the conclusion of the animal or plant's life, resulting in a set amount of carbon-14 in the artifact. Carbon-14 has a half life of 5730 years. By taking a sample of the artifact, one can measure the amount of remaining carbon-14, and hence date the artifact. (The word "artifact" properly means a man-made object, but is often used to mean any object under archaeological examination.)

There are a number of ways of actually doing the dating process. Libby initially used a process called a "screen wall" counter, basically a form of geiger



counter. There are two major processes used today, the gas proportional counter and the liquid scintillation counter. The decision as to which process to use is dependent largely on the size of the sample to be tested; the gas proportional counter can use small samples while the liquid scintillation counter can handle large samples, but not vice versa.

### Gas Proportional

In the gas proportional process, a fine wire, charged to a high voltage, is strung down the center of a metal tube. The sample is introduced in the form of a gas produced from the carbon in the sample. When carbon-14 decays, the radiation it emits produces free electrons in the gas, which are collected by the wire where an electrical impulse is generated. This is counted and the number of impulses, expressed as disintegrations per minute (dpm). A fresh sample, that is, one that has recently died, will have a dpm rate of 15, one 5730 years old a dpm of 7.5 and so on. It is accurate up to about 50,000 years.

The difficulty with this system is the amount of background radiation affecting the counter while the sample is being tested. To overcome this, an anticoincidence counter is arranged such that if it registers a disintegration at the same time as the counter registers a disintegration, the disintegration is automatically discounted. This is because the disintegration registered by both counters could only have occurred by some external radiation source, and not from the sample being tested. The disadvantage to this system is that it must be made quite large to accommodate a large sample, since the gas is of a relatively low density. When the counter becomes large, the background rate goes up, the shielding and anticoincidence counter become still larger, and the advantages are generally outweighed by the disadvantage of size.

### Liquid Scintillation

A second method to test for carbon-14 is the liquid scintillation counter system. The carbon in the sample is converted into an organic liquid such as benzene. Other chemicals, added to the benzene, emit flashes of light (scintillations) when radiation passes through them. The solution is placed in a glass bottle and monitored with photomultipliers which convert the scintillations into electrical impulses which can be counted. The difficulty with this system is that low backgrounds cannot be obtained because of the minimum amount of electrical noise in this type of system. However, for large samples, this disadvantage is overcome because the liquid is relatively dense.

There are a number of other similar



A terra-cotta statuette originally thought to be of Etruscan origin between 510 and 490 BC. Thermoluminescence dating disclosed that the statue was a fake of modern origin. Photos courtesy of Stuart Fleming Research Laboratory for Archaeology.



such processes, involving the half-lives of radioactive potassium-argon-40 (used to date *Zinjanthropus*, the "human" skull found in 1959 at Olduvai Gorge by Dr. Leakey), rubidium-strontium, lead-204 and some twenty others. Each has an especial, limited use and a writer on this subject quickly gets into the grey area between Archaeology and the dating of geological formations.

One of the most common artifacts found at an archaeological dig are potsherds, the remnants of broken pottery. A method for dating them, originally derived at Oxford University, involves thermoluminescence.

### Thermoluminescence

The method itself is based on the principle that radiation distorts the electronic structure of insulating materials and so stores energy within the material. This process may be likened to the stretching of a spring. When the material is heated to a certain temperature, the forces holding the electrons "out of place" begin to "loosen", the structure relaxes as a stretched spring would and the stored energy is released. The released energy is emitted in the form of light. The radiation that produces this deformation comes mainly from naturally occurring radioactive materials like uranium, thorium and potassium which are present in the pottery in low concentrations. The soil in which the pottery was buried also contains naturally radioactive material which affects the pottery in the same way. Cosmic radiation also contributes to the radiation damage. As time passes, the pottery absorbs more and more radiation, starting from the last time the pottery released its stored energy, that is, when it was annealed (baked or fired).

By carefully powdering a sample, taking care not to heat it (so that the thermoluminescence is not inadvertently released), and then gently heating it in a precisely controlled oven, the release of light can be detected by photomultipliers and recorded. Then the examiner must

deduct the amount of thermoluminescence expected to have been absorbed by the sample from the surrounding soil since the last time it was annealed, and further, deduct the amount of cosmic ray uptake. When all the arithmetic has been done, then a fairly accurate reading can be obtained as to the sample's age. Not only potsherds, but ceramic and terra-cotta statuary can be analyzed this way, resulting, on occasion, in the finding of forgeries. Its major disadvantage is that it is destructive.

A second method utilizing radiation damage was developed in the early Sixties and is called fission-track studies.

### Tracking Uranium

Essentially, uranium-238 occasionally splits into two parts, similar to the reaction in a nuclear reactor. It does not, however, happen very often; only 84 spontaneous emissions occur per million atoms per million years.

When the fission occurs in a piece of pottery, the two parts of the split atom leave a tiny trail of damage in the crystal structure of the material. If this happens close to the surface of the specimen, the trail will penetrate the surface and can be detected.

The detection process consists of taking a tiny slice of the specimen (as small as a square millimeter) which is then cleaned and polished. An acidic solution is then applied to the surface. This attacks the specimen and eats away at its surface. The tracks of the fission become enlarged to such an extent that they can then be observed with an ordinary microscope. By counting these holes, or etch pits, in a known area, one obtains the number of fissions that occurred in that area since the pottery was annealed.

The second step in the dating process is to determine how much uranium is present in the area where the tracks were counted. By irradiating the specimen with a known quantity of neutrons, one can cause the uranium-235 atoms to fission.



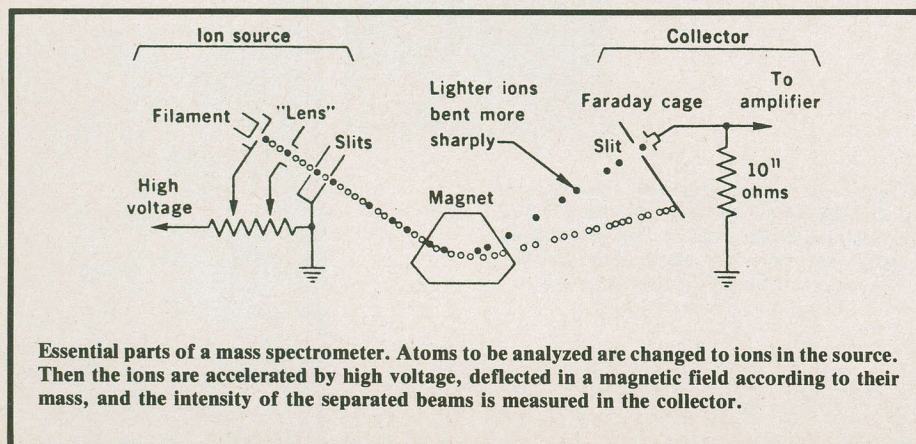
Because the uranium-235 is customarily considered to be in a fixed proportion to the uranium-238 (though see OKLO, ETI, July, 1983), the number of new fission tracks in the area previously observed is a measure of the amount of uranium-238 in that area and may be easily calculated.

The accuracy of this method is dependent on the amount of uranium found in the clay from which the pottery was made, customarily 1 part per million. Such a concentration permits the determination of ages as recent as 100,000 years with an uncertainty of 10%. However, as the concentration of uranium goes up to, say, 100 parts per million, ages as recent as 1,000 years can be determined. With a concentration of 1%, ages as recent as 10 years can be determined. Further, glass, which has had uranium deliberately added as a coloring agent, can have its age determined by this method.

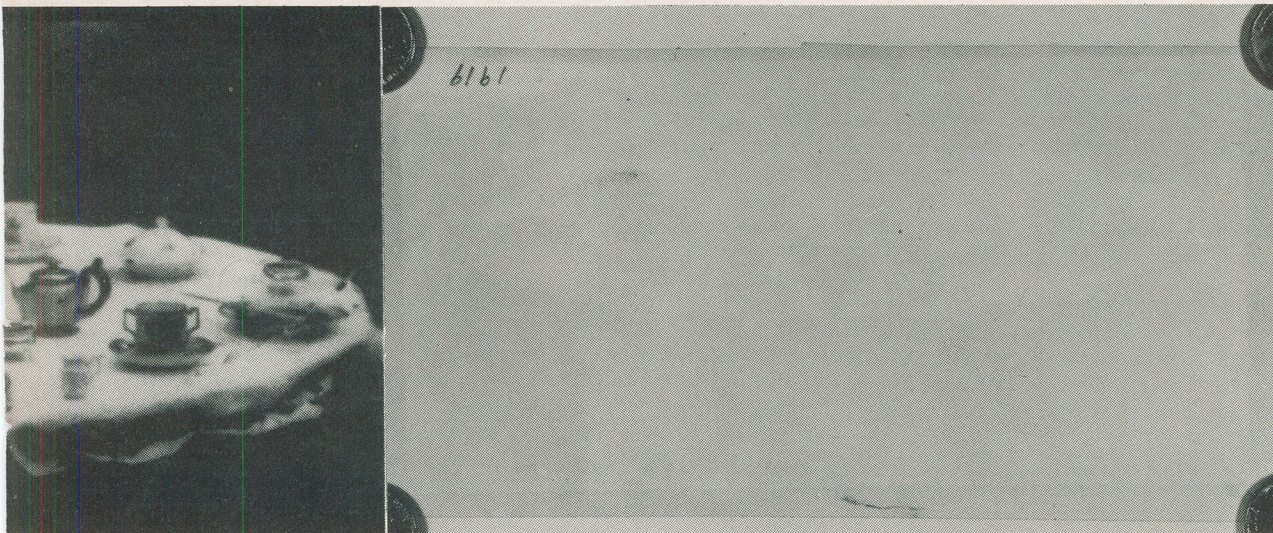
### Fingerprints and Neutrons

Fingerprinting, that is, the determination of trace elements (less than 0.01%), is a non-destructive way of measuring very small quantities of elements such that similarities and differences can be determined, which in turn permit a better understanding of archaeological economics.

While trace elements can be determined by ordinary chemical methods large samples would be required that might ruin valuable objects. The main form of fingerprinting, the neutron activation process (NAA), has the great advantage that it is non-destructive. Analysis by means of this method (outlined in more detail in ART, ETI, July, 1983) consists of bombarding the atoms of an element in a sample with neutrons in a reactor. This causes some of the atoms to absorb a neutron. In most cases, this will result in some fraction of these atoms becoming radioactive.







(Upper photo) A faded photographic plate by photo pioneer William Henry Talbot. (Far left) Using the neutron activation process, the original photo scene is restored. Both photos courtesy of the Smithsonian Institution.

For example, sodium: when bombarded by slow neutrons, the sodium absorbs a neutron to become a sodium nucleus with 12 rather than 11 neutrons (sodium-24). This decays to a magnesium atom, emitting a beta particle and energy in the form of gamma rays. the number and energy of the gamma rays is unique for the decay of sodium-24 and thus constitutes a kind of signature. Further, measuring the half-life of sodium-24 is also a means of identification. In other words, by this method one can determine that sodium is present by later observing the energies of gamma rays from sodium-24 and can determine how much is present by measuring how many such gamma rays are emitted. The sensitivity of this process is very good, with gold being capable of being detected in quantities as small as a millionth of one millionth of a gram (one picogram).

An example of the use of the NAA process involved determining the source of material for Indian arrowheads made of obsidian. At the University of Michigan, Adon A. Gordus was able to pinpoint the material used by the Hopewell Indians, a group that inhabited what is now Ohio, Illinois, Michigan and Wisconsin during the period 300 BC to 500 AD.

The puzzle was that while obsidian arrowheads were found in Hopewell burial mounds, the closest sources of that material are in the Western U.S., Mexico and Alaska.

Using NAA, Gordus analysed the arrowheads and the obsidian from all the North American sources for two elements, sodium and manganese. He found that only three sources contained these two elements in concentrations similar to those of the arrowheads. He then used NAA to check for 15 other elements in these sources and found that only the composition of obsidian from one source, Obsidian Cliff in Wyoming's

Yellowstone National Park, corresponded to the composition of the arrowheads. Archaeologically, this means that there was some sort of trade route between the two areas.

A second example of NAA is more recent. Early photographic plates tend to become blached with age, such that the picture can no longer be seen. However, by irradiating the plate with slow neutrons, and then placing a photographic film in contact with the plate, the gamma decay will effect the modern photographic plate, permitting an image of the previously "unseeable" picture to become apparent.

### **Carbon-14 dating is only one of a number of nuclear applications which answer questions about archaeological finds.**

One specific example of this is the 19th century picture currently in the Smithsonian Institution, taken by the English antiquarian, physicist and pioneer in optics and photography, William Henry Fox Talbot. Talbot's plate is now blank, but under NAA reveals the original picture, a table setting.

### **Sparks and Spectrums**

A second form of fingerprinting involves spark source mass spectrometry. In this method, a sample from an artifact is subjected to a very hot, electrically produced spark. A small part of the specimen, usually metal, is vaporized and the individual atoms become electrically charged or ionized. This process takes place at one end of a curved metal tube that has been evacuated to a low pressure. The metallic ions are then accelerated in an electrical field of about 1000-2000 volts in

such a way that a narrow beam of ions travel down the tube.

At the point where the tube bends, there is a magnetic field that bends the path of the ions. The important point is that the amount that the path of an ion bends is determined in part by its mass. The arrangement produces a separation of ions into numerous beams according to their mass. The beams eventually strike a photographic plate that upon being developed, shows a series of lines corresponding in position to the masses of the ions which struck the plate. The intensity or blackness of each line is a function of the concentration of the element at that mass number. By comparing such photographs from different sources, and different finished products, the archaeologist can determine ancient trade patterns, eg. equating a coin minted in Rome with a gold mine in Spain, for instance.

### **Lead Isotopes**

A third type of fingerprinting used by archaeologists involves lead isotope ratios. The metal lead has been used by man in one form or another for thousands of years. It is obviously present in things made mainly of lead, but is also a minor constituent of many alloys, including bronze and brass. In addition, glazes containing lead have been used in pottery, and glass sometimes is colored by having lead compounds added to it.

The fingerprint for lead is the relative amounts of the four stable (non-radioactive) isotopes of lead found in nature: lead-204, -206, -207 and -208. The ratios of the lead isotopes in any given lead ore deposit were initially determined by the timing of the geological event that took place when the deposit was being formed.

The relative amounts of the isotopes in a sample can be determined with a mass



## Electronics in Archaeology

spectrometer similar to the one detailed above. However, only the four isotopes of lead and their ratios are of interest. The four separated beams which are obtained bombard the metal plate one at a time. By slightly varying the beam accelerating voltage to focus each mass on the plate in succession, the number of ions of each mass striking the plate can be measured with a device called an electrometer. Accuracy is within 1%.

The main disadvantage in studying lead isotopes and their ratios is that these ratios are not unique to any given lead mine. However, the method can be used to prove that the lead in an object did *not* come from a particular place. When this information is used in conjunction with other information (trace element patterns, perhaps) it can be quite useful in establishing the ultimate source of material, and indirectly, the trading habits of the peoples who created them. For example, Swiss workers were able to trace the sources of lead used in Roman water piping to various ancient lead mines in England, Spain and Central Europe.

### Beta Backscatter

Energetic electrons, better known as beta rays, are another tool used in archaeological studies. Emitted by many radioactive atoms, beta rays striking a sur-

face are either absorbed or penetrated a little way and are bounced back (backscattered). Elements having a higher atomic number are more efficient backscatterers.

This process has been used as a non-destructive means of measuring the amount of lead in leaded glass and in pottery that has been finished with a lead glaze. Essentially, a beta ray emitting radioisotope is allowed to shine on the surface being analyzed and a geiger counter measures the beta rays that are reflected. The more lead there is in the surface, the more scattered radiation is measured by the counter. An example of its use was in the study of the famous English crystal glass known as Ravenscroft, produced towards the end of the 17th century. Analysis of pieces from that time and from a century later showed that the amount of lead used was increased as time went on.

One of the more interesting applications of nuclear processes to the study of archaeology involves the Mossbauer Effect, first determined in the late 1950s by Rudolf Mossbauer. He then discovered the key to a method in which the nuclear properties of certain elements can be affected by their chemical and physical circumstances. While relatively few elements can be studied by this means, iron happens to be the easiest, which is ar-

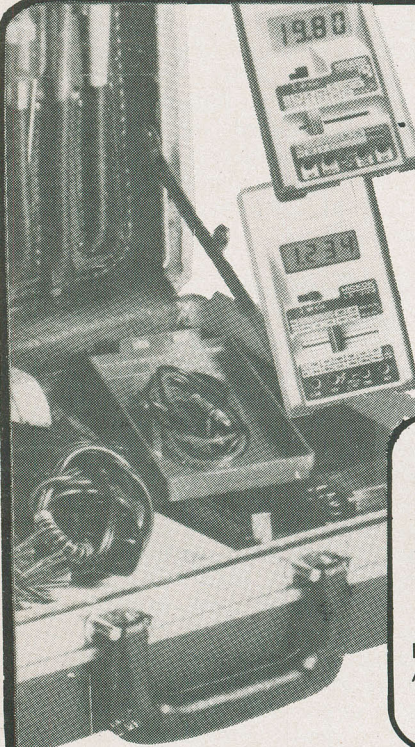
chaeologically fortunate, since iron compounds, especially oxides, have been used to add color to pottery for thousands of years.

### Resonance Absorption

In the case of iron, one begins with a specially prepared radioactive source containing cobalt-57. The radiation from this source is allowed to pass through a thin layer of the sample and then falls upon a detector where the amount of radiation is measured. While part of any radiation is absorbed when passing through any material, some of the radiation from the cobalt-57 source is very special, archaeologically.

This special radiation, which consists of gamma rays with an energy of about 14 keV, tends to be preferentially absorbed by the nuclei of iron-57 atoms because it is exactly the right energy; in other words, the iron-57 is resonance-absorptive. The exactness is important, as the slightest alteration will destroy the resonance absorption.

Utilizing the Mossbauer effect, the scientist moves the radioactive source at various velocities back and forth and measures the radioactivity reaching the detector at each one. If the iron in the sample is at a particular state, dependent upon its heat when being annealed, a state



LX304 digital multimeter with automatic decimal point, built in low battery indicator and transistor testing capability.

**\$138.00**

LX303 digital multimeter with easy-to-read LCD display. Only **\$131.00**

Model 216 Transistor Tester with fast, automatic switching for instant good-bad analysis of NPN's, PNP's, FET's, diodes and SCR's in or out of circuit.

**\$182.00**

Model 240 Video Generator with 10 step gray scale staircase for VTR, CCTV monitor and TV applications. **\$245.00**

**HICKOK**  
the value innovator

**H**ROGERS electronic instruments Ltd.

P.O. Box 310, 595 Mackenzie Ave. Units 1&2  
Ajax, Ontario L1S 3C5. Tel. (416) 683-4211  
Duty and FST included. ChargeX (Visa) accepted.  
Ontario residents add 7% sales tax. Shipping extra.

**FOR THOSE  
ON THE GO  
FROM...**

**HICKOK**  
the value innovator

**H**ROGERS electronic instruments Ltd.

# Your Toolbox Test Bench

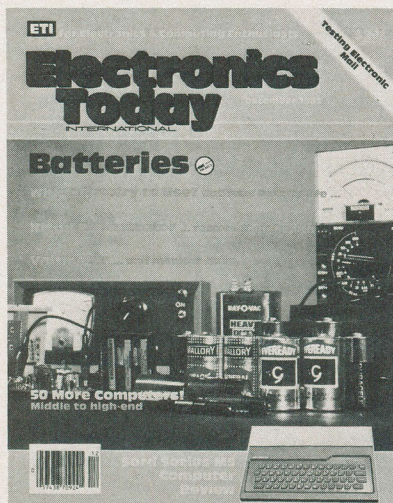
Circle No. 1 on Reader Service Card.







**THE ONLY WAY TO BE SURE OF  
YOUR ISSUE EACH MONTH**



**BOOKS, BACK ISSUES  
BINDERS—SEE OVER**

Code \_\_\_\_\_

Electronics Today Magazine, Unit 6, 25 Overlea Blvd., Toronto, Ontario M4H 1B1.

**ORDER** ☐ Please fill out form overleaf  
**SUBSCRIPTIONS:** ☐ NEW SUBSCRIPTION? ☐ Or... ☐ RENEWAL? Please check one.

☐ One year subscription (12 issues) \$18.95 ☐ Two year subscription (24 issues) \$33.95. Postage and handling to Canada is included, for U.S. please add \$3 ☐ other countries add \$5/yr. ☐

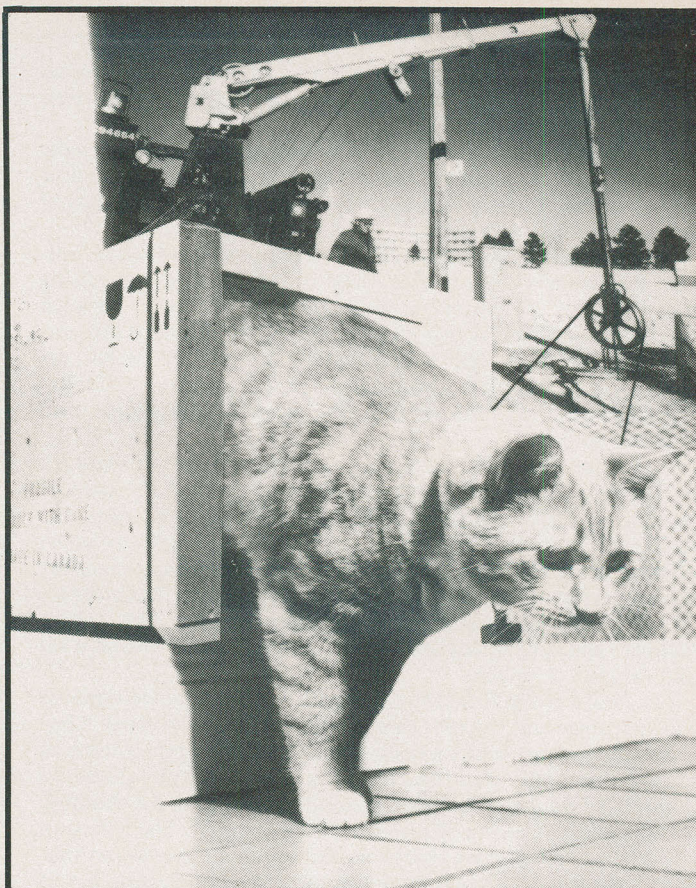


NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
TOWN/CITY \_\_\_\_\_ PROVINCE/STATE \_\_\_\_\_  
CODE \_\_\_\_\_ DATE \_\_\_\_\_

☐ Cheque enclose DO NOT send cash  
☐ Bill Mastercard A/C No. \_\_\_\_\_  
☐ Bill Visa A/C No. \_\_\_\_\_

Signature \_\_\_\_\_  
Expiry Date \_\_\_\_\_

**PLEASE ALLOW 6—8 WEEKS FOR YOUR FIRST MAGAZINE TO ARRIVE**



Dockworkers in New York City unload Canada's most amazing contribution to technology since the Canadarm: The Bionic Ratcatcher. The 57-tonne cat clone was a product of reverse microtechnology, though it includes two Z80 CPUs to assist in rat detection. The collar tag alone weighs 520 kg. New York City officials are optimistic that the Canadian-built unit will solve the city's rat problem, though they admit that there may be some interference with traffic.

To keep abreast of technological miracles like these, may we suggest a subscription to Electronics Today International? Even people who are not interested in oversize cats have said "Gosh, there are lots of other pages!" On those pages, you'll find projects for both the beginner and the advanced builder, basic electronic theory articles, and up-to-date reporting on the computer scene.

**Have ETI delivered to your door each month; send \$18.95 for one year (12 issues), or \$33.95 for two (24 issues), using the coupon on this page, or send to:**

**Blatant Ripoff!!!** The intricacies of inflation have forced us to raise the newsstand price of ETI.

Subscriptions, however, remain the same price. There's a moral here.

You can save 43 to 49% depending on the term. Subscribe now!!!

**ETI SUBSCRIPTIONS  
UNIT 6, 25 OVERLEA BLVD.,  
TORONTO, ONTARIO M4H 1B1**



## ELECTRONICS BEGINNERS

### PH255: COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS, 2nd Edition

J. DOUGLAS-YOUNG \$10.45  
Packed with scores of easy-to-understand diagrams and invaluable troubleshooting tips as well as a circuit finder chart and a new section on logic circuits.

### PH251: BEGINNER'S HANDBOOK OF IC PROJECTS

D. HEISERMAN \$17.45  
Welcome to the world of integrated circuit (IC) electronic projects. This book contains over 100 projects (each including a schematic diagram, parts list, and descriptive notes).

### PH252: DIGITAL ICs: HOW THEY WORK AND HOW TO USE THEM

A. BARBER \$11.45  
The dozens of illustrations included in this essential reference book will help explain time-saving test procedures, interpreting values, performing voltage measurements, and much more!

### PH249: THE BEGINNER'S HANDBOOK OF ELECTRONICS

G. OLSEN & M. MIMS, III \$11.45  
In this basic book, the authors cover the entire spectrum of modern electronics, including the use of such components as integrated circuits and semiconductor devices in record players, radio receivers, airplane guidance systems, and many others.

### THE BEGINNER'S HANDBOOK OF ELECTRONICS

AB003 \$11.45  
An excellent textbook for those interested in the fundamentals of Electronics. This book covers all major aspects of power supplies, amplifiers, oscillators, radio, television and more.

## ELECTRONIC THEORY

### ELEMENTS OF ELECTRONICS — AN ON-GOING SERIES

F.A. WILSON, C.G.I.A., C.Eng.  
BP62: BOOK 1. The Simple Electronic Circuit and Components \$8.95

BP63: BOOK 2. Alternating Current Theory \$8.95

BP64: BOOK 3. Semiconductor Technology \$8.95

BP77: BOOK 4. Microprocessing Systems And Circuits \$12.30

BP89: BOOK 5. Communication \$12.30  
The aim of this series of books can be stated quite simply — it is to provide an inexpensive introduction to modern electronics so that the reader will start on the right road by thoroughly understanding the fundamental principles involved.

Although written especially for readers with no more than ordinary arithmetical skills, the use of mathematics is not avoided, and all the mathematics required is taught as the reader progresses.

Each book is a complete treatise of a particular branch of the subject and, therefore, can be used on its own with one proviso, that the later books do not duplicate material from their predecessors, thus a working knowledge of the subjects covered by the earlier books is assumed.

BOOK 1: This book contains all the fundamental theory necessary to lead to a full understanding of the simple electronic circuit and its main components.

BOOK 2: This book continues with alternating current theory without which there can be no comprehension of speech, music, radio, television or even the electricity utilities.

BOOK 3: Follows on semiconductor technology, leading up to transistors and integrated circuits.

BOOK 4: A complete description of the internal workings of microprocessor.

BOOK 5: A book covering the whole communication scene.

PH241: DC ELECTRONICS \$17.45  
Covers everything from voltage current, and resistance relationships to more advanced studies of electrical measurements, circuits, resistors, capacitors, and inductors.

PH242: AC ELECTRONICS \$17.45  
Covers AC fundamentals and theory. Includes discussions and experiments in resonance and reactance; RC, RL, and RLC circuits; and how to work with formulas to analyze the operations of AC circuitry.

PH243: ELECTRONICS CIRCUITS \$17.45  
Covers all of the most popular electronic circuits, with emphasis on integrated circuits.

PH244: SEMICONDUCTOR DEVICES \$17.45  
Covers semiconductor fundamentals, diodes, zeners, bipolar transistor operation and characteristics, FETs, thyristors, ICs, and optoelectronics.

PH247: DIGITAL TECHNIQUES \$20.45  
Covers logic circuits, Boolean Algebra, flip-flops, registers, combinational logic circuitry, and digital design.

### Tab1531: CONCEPTS OF DIGITAL ELECTRONICS \$22.45

This book erases the mysteries surrounding digital electronics theory. Understand and use low-cost 7400 series IC's to produce working digital devices including a power supply and a breadboard experimenter.

## PROJECTS

### BP48: ELECTRONIC PROJECTS FOR BEGINNERS \$5.90

F.G. RAYER, T.Eng.(CEI), Assoc.IERE  
Another book written by the very experienced author — Mr. F.G. Rayer — and in it the newcomer to electronics, will find a wide range of easily made projects. Also, there are a considerable number of actual component and wiring layouts, to aid the beginner.

Furthermore, a number of projects have been arranged so that they can be constructed without any need for soldering and, thus, avoid the need for a soldering iron.

Also, many of the later projects can be built along the lines as those in the 'No Soldering' section so this may considerably increase the scope of projects which the newcomer can build and use.

### 221: 28 TESTED TRANSISTOR PROJECTS

R.TORRENS \$5.50

Mr. Richard Torrens is a well experienced electronics development engineer and has designed, developed, built and tested the many useful and interesting circuits included in this book. The projects themselves can be split down into simpler building blocks, which are shown separated by boxes in the circuits for ease of description, and also to enable any reader who wishes to combine boxes from different projects to realise ideas of his own.

### BP49: POPULAR ELECTRONIC PROJECTS \$6.25

R.A. PENFOLD  
Includes a collection of the most popular types of circuits and projects which, we feel sure, will provide a number of designs to interest most electronics constructors. The projects selected cover a very wide range and are divided into four basic types: Radio Projects, Audio Projects, Household Projects and Test Equipment.

### EXPERIMENTER'S GUIDE TO SOLID STATE ELECTRONIC PROJECTS

AB007 \$10.45  
An ideal sourcebook of Solid State circuits and techniques with many practical circuits. Also included are many useful types of experimenter gear.

### BP71: ELECTRONIC HOUSEHOLD PROJECTS \$7.70

R. A. PENFOLD  
Some of the most useful and popular electronic construction projects are those that can be used in or around the home. The circuits range from such things as '2 Tone Door Buzzer', Intercom, through Smoke or Gas Detectors to Baby and Freezer Alarms.

### BP94: ELECTRONIC PROJECTS FOR CARS AND BOATS \$8.10

R.A. PENFOLD  
Projects, fifteen in all, which use a 12V supply are the basis of this book. Included are projects on Windscreen Wiper Control, Courtesy Light Delay, Battery Monitor, Cassette Power Supply, Lights Timer, Vehicle Immobiliser, Gas and Smoke Alarm, Depth Warning and Shaver Inverter.

### BP69: ELECTRONIC GAMES \$7.55

R.A. PENFOLD  
In this book Mr. R. A. Penfold has designed and developed a number of interesting electronic game projects using modern integrated circuits. The text is divided into two sections, the first dealing with simple games and the latter dealing with more complex circuits.

### BP95: MODEL RAILWAY PROJECTS \$8.10

Electronic projects for model railways are fairly recent and have made possible an amazing degree of realism. The projects covered include controllers, signals and sound effects: striboard layouts are provided for each project.

### BP93: ELECTRONIC TIMER PROJECTS \$8.10

F.G. RAYER  
Windscreen wiper delay, darkroom timer and metronome projects are included. Some of the more complex circuits are made up from simpler sub-circuits which are dealt with individually.

### 110 OP-AMP PROJECTS

MARSTON \$13.45

HB24  
This handbook outlines the characteristics of the op-amp and present 110 highly useful projects—ranging from simple amplifiers to sophisticated instrumentation circuits.

### 110 IC TIMER PROJECTS

GILDER \$11.45

HB25  
This sourcebook maps out applications for the 555 timer IC. It covers the operation of the IC itself to aid you in learning how to design your own circuits with the IC. There are application chapters for timer-based instruments, automotive applications, alarm and control circuits, and power supply and converter applications.

### BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING \$8.10

R.A. PENFOLD

We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

### PH250: EXPERIMENTER'S GUIDE TO SOLID STATE ELECTRONICS PROJECTS

A. BARBER \$10.45

This book takes the mystery out of solid state electronics and enables the reader to build such useful devices as: series regulated power supplies, light dimmers, solar cell operated radios, hi-fi amplifiers, light indicators for battery operated equipment and much more.

### 110 THYRISTOR PROJECTS USING SCRs AND TRIACS

MARSTON \$13.45

HB22  
A grab bag of challenging and useful semiconductor projects for the hobbyist, experimenter, and student. The projects range from simple burglar, fire, and water level alarms to sophisticated power control devices for electric tools and trains. Integrated circuits are incorporated wherever their use reduces project costs.

### 110 CMOS DIGITAL IC PROJECTS

MARSTON \$11.75

HB23  
Outlines the operating characteristics of CMOS digital ICs and then presents and discusses 110 CMOS digital IC circuits ranging from inverter gate and logic circuits to electronic alarm circuits. Ideal for amateurs, students and professional engineers.

### BP76: POWER SUPPLY PROJECTS \$7.30

R.A. PENFOLD

Line power supplies are an essential part of many electronics projects. The purpose of this book is to give a number of power supply designs, including simple unregulated types, fixed voltage regulated types, and variable voltage stabilised designs, the latter being primarily intended for use as bench supplies for the electronics workshop. The designs provided are all low voltage types for semiconductor circuits.

There are other types of power supply and a number of these are dealt with in the final chapter, including a cassette power supply, Ni-Cad battery charger, voltage step up circuit and a simple inverter.

### BP84: DIGITAL IC PROJECTS \$8.10

F.G. RAYER, T.Eng.(CEI), Assoc.IERE

This book contains both simple and more advanced projects and it is hoped that these will be found of help to the reader developing a knowledge of the workings of digital circuits. To help the newcomer to the hobby the author has included a number of board layouts and wiring diagrams. Also the more ambitious projects can be built and tested section by section and this should help avoid or correct faults that could otherwise be troublesome. An ideal book for both beginner and more advanced enthusiast alike.

### BP67: COUNTER DRIVER AND NUMERAL DISPLAY PROJECTS \$7.55

F.G. RAYER, T.Eng.(CEI), Assoc. IERE

Numerical indicating devices have come very much to the forefront in recent years and will, undoubtedly, find increasing applications in all sorts of equipment. With present day integrated circuits, it is easy to count, divide and display numerically the electrical pulses obtained from a great range of driver circuits.

In this book many applications and projects using various types of numeral displays, popular counter and driver IC's etc. are considered.

### BP73: REMOTE CONTROL PROJECTS \$8.60

OWEN BISHOP

This book is aimed primarily at the electronics enthusiast who wishes to experiment with remote control. Full explanations have been given so that the reader can fully understand how the circuits work and can more easily see how to modify them for other purposes, depending on personal requirements. Not only are radio control systems considered but also infra-red, visible light and ultrasonic systems as are the use of Logic ICs and Pulse position modulation etc.

### BP99: MINI — MATRIX BOARD PROJECTS \$8.10

R.A. PENFOLD

Twenty useful projects which can all be built on a 24 x 10 hole matrix board with copper strips. Includes Doorbuzzer, Low-voltage Alarm, AM Radio, Signal Generator, Projector Timer, Guitar Headphone Amp, Transistor Checker and more.

### BP103: MULTI-CIRCUIT BOARD PROJECTS \$8.10

R.A. PENFOLD

This book allows the reader to build 21 fairly simple electronic projects, all of which may be constructed on the same printed circuit board. Wherever possible, the same components have been used in each design so that with a relatively small number of components and hence low cost, it is possible to make any one of the projects or by re-using the components and P.C.B. all of the projects.

### Tab1431: DIGITAL ELECTRONIC PROJECTS \$21.45

Build a deluxe code oscillator, a digital game called Climb-the-Mountain, a clock with alarm, a metric measuring wheel, a modular decade counter, even a 14-note music generator. 17 projects in all.

### BP107: 30 SOLDERLESS BREADBOARD PROJECTS — BOOK 1 \$9.35

R.A. PENFOLD

A "Solderless Breadboard" is simply a special board on which electronic circuits can be built and tested. The components used are just plugged in and unplugged as desired. The 30 projects featured in this book have been specially designed to be built on a "Verobloc" breadboard. Wherever possible the components used are common to several projects, hence with only a modest number of reasonably inexpensive components it is possible to build, in turn, every project shown.



# Electronics



## BP106: MODERN OP-AMP PROJECTS \$8.10 R.A. PENFOLD

Features a wide range of constructional projects which make use of op-amps including low-noise, low distortion, ultra-high input impedance, high slew-rate and high output current types.

## CIRCUITS

## BP80: POPULAR ELECTRONIC CIRCUITS — BOOK 1 \$8.25 R.A. PENFOLD

Another book by the very popular author, Mr. R.A. Penfold, who has designed and developed a large number of various circuits. These are grouped under the following general headings: Audio Circuits, Radio Circuits, Test Gear Circuits, Music Project Circuits, Household Project Circuits and Miscellaneous Circuits.

## BP98: POPULAR ELECTRONIC CIRCUITS, BOOK 2 \$9.35 R.A. PENFOLD

70 plus circuits based on modern components aimed at those with some experience.

## The GIANT HANDBOOK OF ELECTRONIC CIRCUITS TAB No.1300 \$28.45

About as twice as thick as the Webster's dictionary, and having many more circuit diagrams, this book is ideal for any experimenter who wants to keep amused for several centuries. If there isn't a circuit for it in here, you should have no difficulty convincing yourself you don't really want to build it.

## BP39: 50 (FET) FIELD EFFECT TRANSISTOR PROJECTS \$5.50 F.G. RAYER, T.Eng.(CEI),Assoc.IERE

Field effect transistors (FETs), find application in a wide variety of circuits. The projects described here include radio frequency amplifiers and converters, test equipment and receiver aids, tuners, receivers, mixers and tone controls, as well as various miscellaneous devices which are useful in the home.

This book contains something of particular interest for every class of enthusiast — short wave listener, radio amateur, experimenter or audio devotee.

## BP87: SIMPLE L.E.D. CIRCUITS \$5.90 R.N. SOAR

Since it first appeared in 1977, Mr. R.N. Soar's book has proved very popular. The author has developed a further range of circuits and these are included in Book 2. Projects include a Transistor Tester, Various Voltage Regulators, Testers and so on.

## BP42: 50 SIMPLE L.E.D. CIRCUITS \$3.55 R.N. SOAR

The author of this book, Mr. R.N. Soar, has compiled 50 interesting and useful circuits and applications, covering many different branches of electronics, using one of the most inexpensive and freely available components — the Light Emitting Diode (L.E.D.). A useful book for the library of both beginner and more advanced enthusiast alike.

## BP82: ELECTRONIC PROJECTS USING SOLAR CELLS \$8.10 OWEN BISHOP

The book contains simple circuits, almost all of which operate at low voltage and low currents, making them suitable for being powered by a small array of silicon cells. The projects cover a wide range from a bicycle speedometer to a novelty 'Duck Shoot'; a number of power supply circuits are included.

## BP37: 50 PROJECTS USING RELAYS, SCR's & TRIACS \$5.50 F.G. RAYER, T.Eng.(CEI),Assoc.IERE

Relays, silicon controlled rectifiers (SCR's) and bi-directional triodes (TRIACS) have a wide range of applications in electronics today. This book gives tried and practical working circuits which should present the minimum of difficulty for the enthusiast to construct. In most of the circuits there is a wide latitude in component values and types, allowing easy modification of circuits or ready adaptation of them to individual needs.

## BP24: 50 PROJECTS USING IC741 \$4.25 RUDI & UWE REDMER

This book, originally published in Germany by TOPP, has achieved phenomenal sales on the Continent and Babani decided, in view of the fact that the integrated circuit used in this book is inexpensive to buy, to make this unique book available to the English speaking reader. Translated from the original German with copious notes, data and circuitry, a "must" for everyone whatever their interest in electronics.

## BP83: VMOS PROJECTS \$8.20 R.A. PENFOLD

Although modern bipolar power transistors give excellent results in a wide range of applications, they are not without their drawbacks or limitations. This book will primarily be concerned with VMOS power FETs although power MOSFETs will be dealt with in the chapter on audio circuits. A number of varied and interesting projects are covered under the main headings of: Audio Circuits, Sound Generator Circuits, DC Control Circuits and Signal Control Circuits.

## BP44: IC 555 PROJECTS \$7.55 E.A. PARR, B.Sc.,C.Eng., M.I.E.E.

Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer is such a device. Included in this book are Basic and General Circuits, Motor Car and Model Railway Circuits, Alarms and Noise Makers as well as a section on the 556, 558 and 559 timers.

## BP65: SINGLE IC PROJECTS \$6.55 R.A. PENFOLD

There is now a vast range of ICs available to the amateur market, the majority of which are not necessarily designed for use in a single application and can offer unlimited possibilities. All the projects contained in this book are simple to construct and are based on a single IC. A few projects employ one or two transistors in addition to an IC but in most cases the IC is the only active device used.

## BP97: IC PROJECTS FOR BEGINNERS \$8.10 F.G. RAYER

Covers power supplies, radio, audio, oscillators, timers and switches. Aimed at the less experienced reader, the components used are popular and inexpensive.

## BP88: HOW TO USE OP AMPS \$9.35 E.A. PARR

A designer's guide covering several op amps, serving as a source book of circuits and a reference book for design calculations. The approach has been made as non-mathematical as possible.

## IC ARRAY COOKBOOK JUNG \$14.25 HB26

A practical handbook aimed at solving electronic circuit application problems by using IC arrays. An IC array, unlike specific-purpose ICs, is made up of uncommitted IC active devices, such as transistors, resistors, etc. This book covers the basic types of such ICs and illustrates with examples how to design with them. Circuit examples are included, as well as general design information useful in applying arrays.

## BP50: IC LM3900 PROJECTS \$5.90 H.KYBETT, B.Sc., C.Eng.

The purpose of this book is to introduce the LM3900 to the Technician, Experimenter and the Hobbyist. It provides the groundwork for both simple and more advanced uses, and is more than just a collection of simple circuits or projects.

Simple basic working circuits are used to introduce this IC. The LM3900 can do much more than is shown here, this is just an introduction. Imagination is the only limitation with this useful and versatile device. But first the reader must know the basics and that is what this book is all about.

## 223: 50 PROJECTS USING IC CA3130 \$5.50 R.A. PENFOLD

In this book, the author has designed and developed a number of interesting and useful projects which are divided into five general categories: I — Audio Projects II — R.F. Projects III — Test Equipment IV — Household Projects V — Miscellaneous Projects.

## 224: 50 CMOS IC PROJECTS \$4.25 R.A. PENFOLD

CMOS IC's are probably the most versatile range of digital devices for use by the amateur enthusiast. They are suitable for an extraordinary wide range of applications and are also some of the most inexpensive and easily available types of IC.

Mr. R.A. Penfold has designed and developed a number of interesting and useful projects which are divided into four general categories: I — Multivibrators II — Amplifiers and Oscillators III — Trigger Devices IV — Special Devices.

## THE ACTIVE FILTER HANDBOOK TAB No.1133 \$14.45

Whatever your field — computing, communications, audio, electronic music or whatever — you will find this book the ideal reference for active filter design.

The book introduces filters and their uses. The basic math is discussed so that the reader can tell where all design equations come from. The book also presents many practical circuits including a graphic equalizer, computer tape interface and more.

## DIGITAL ICs — HOW THEY WORK AND HOW TO USE THEM \$11.45 AB004

An excellent primer on the fundamentals of digital electronics. This book discusses the nature of gates and related concepts and also deals with the problems inherent to practical digital circuits.

## MASTER HANDBOOK OF 1001 PRACTICAL CIRCUITS TAB No.800 \$20.45

## MASTER HANDBOOK OF 1001 MORE PRACTICAL CIRCUITS TAB No.804 \$24.45

Here are transistor and IC circuits for just about any application you might have. An ideal source book for the engineer, technician or hobbyist. Circuits are classified according to function, and all sections appear in alphabetical order.

## THE MASTER IC COOKBOOK TAB No.1199 \$18.45

If you've ever tried to find specs for a so called 'standard' chip, then you'll appreciate this book. C.L. Hallmark has compiled specs and pinout for most types of ICs that you'd ever want to use.

## ELECTRONIC DESIGN WITH OFF THE SHELF INTEGRATED CIRCUITS AB016 \$13.45

This practical handbook enables you to take advantage of the vast range of applications made possible by integrated circuits. The book tells how, in step by step fashion, to select components and how to combine them into functional electronic systems. If you want to stop being a "cookbook hobbyist", then this is the book for you.

## BP117: PRACTICAL ELECTRONIC BUILDING BLOCKS BOOK 1 \$8.10

Virtually any electronic circuit will be found to consist of a number of distinct stages when analysed. Some circuits inevitably have unusual stages using specialised circuitry, but in most cases circuits are built up from building blocks of standard types.

This book is designed to aid electronics enthusiasts who like to experiment with circuits and produce their own projects rather than simply follow published project designs.

The circuits for a number of useful building blocks are included in this book. Where relevant, details of how to change the parameters of each circuit are given so that they can easily be modified to suit individual requirements.

## PH253: ELECTRONIC DESIGN WITH OFF-THE-SHELF INTEGRATED CIRCUITS Z. MEIKEN & P. TACKRAY \$13.45

A real help for do-it-yourselfers, this handy guide tells professionals and hobbyists alike, how to take components off the shelves, arrange them into circuitry, and make any system perform its desired function.

## AUDIO

## BP90: AUDIO PROJECTS \$8.10 F.G. RAYER

Covers in detail the construction of a wide range of audio projects. The text has been divided into preamplifiers and mixers, power amplifiers, tone controls and matching and miscellaneous projects.

## 205: FIRST BOOK OF HI-FI LOUDSPEAKER ENCLOSURES \$3.55 B.B. BABANI

This book gives data for building most types of loudspeaker enclosure. Includes corner reflex, bass reflex, exponential horn, folded horn, tuned port, klipschorn labyrinth, tuned column, loaded port and multi speaker panoramic. Many clear diagrams for every construction showing the dimensions necessary.

## BP47: MOBILE DISCOTHEQUE HANDBOOK \$5.90 COLIN CARSON

The vast majority of people who start up "Mobile Discos" know very little about their equipment or even what to buy. Many people have wasted a "small fortune" on poor, unnecessary or badly matched apparatus.

The aim of this book is to give you enough information to enable you to have a better understanding of many aspects of "disco" gear.

## HOW TO BUILD A SMALL BUDGET RECORDING STUDIO FROM SCRATCH... TAB No.1166 \$16.45

The author, F. Alton Everest, has gotten studios together several times, and presents twelve complete, tested designs for a wide variety of applications. If all you own is a mono cassette recorder, you don't need this book. If you don't want your new four track to wind up sounding like one, though, you shouldn't be without it.

## BP51: ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING \$5.50 M.K. BERRY

Electronic music is the new music of the Twentieth Century. It plays a large part in "pop" and "rock" music and, in fact, there is scarcely a group without some sort of synthesiser or other effects generator.

This book sets out to show how electronic music can be made at home with the simplest and most inexpensive of equipment. It then describes how the sounds are generated and how these may be recorded to build up the final composition.

## BP74: ELECTRONIC MUSIC PROJECTS \$7.70 R.A. PENFOLD

Although one of the more recent branches of amateur electronics, electronic music has now become extremely popular and there are many projects which fall into this category. The purpose of this book is to provide the constructor with a number of practical circuits for the less complex items of electronic music equipment, including such things as a Fuzz Box, Waa-Waa Pedal, Sustain Unit, Reverberation and Phaser-Units, Tremelo Generator etc.



# Electronics

## BP81: ELECTRONIC SYNTHESIZER PROJECTS \$7.30 M.K. BERRY

One of the most fascinating and rewarding applications of electronics is in electronic music and there is hardly a group today without some sort of synthesizer or effects generator. Although an electronic synthesizer is quite a complex piece of electronic equipment, it can be broken down into much simpler units which may be built individually and these can then be used or assembled together to make a complete instrument.

## ELECTRONIC MUSIC SYNTHESIZERS TAB No.1167 \$11.45

If you're fascinated by the potential of electronics in the field of music, then this is the book for you. Included is data on synthesizers in general as well as particular models. There is also a chapter on the various accessories that are available.

## Tab1364: DESIGNING, BUILDING AND TESTING YOUR OWN SPEAKER SYSTEM ... WITH PROJECTS \$14.45

Covers the theory of speaker construction and describes a variety of plans for speaker system projects ranging from simple setups to complex multi-driver systems. Enclosure design is covered in very good detail.

## BP68: CHOOSING AND USING YOUR HI-FI MAURICE L. JAY \$7.25

The main aim of this book is to provide the reader with the fundamental information necessary to enable him to make a satisfactory choice from the extensive range of hi-fi equipment now on the market.

Help is given to the reader in understanding the equipment he is interested in buying and the author also gives his own opinion of the minimum standards and specifications one should look for. The book also offers helpful advice on how to use your hi-fi properly so as to realise its potential. A Glossary of terms is also included.

## TEST EQUIPMENT

## BP75: ELECTRONIC TEST EQUIPMENT CONSTRUCTION \$7.30 F.G. RAYER, T.Eng. (CEI), Assoc. IERE

This book covers in detail the construction of a wide range of test equipment for both the Electronics Hobbyists and Radio Amateur. Included are projects ranging from an FET Amplified Voltmeter and Resistance Bridge to a Field Strength Indicator and Heterodyne Frequency Meter. Not only can the home constructor enjoy building the equipment but the finished projects can also be usefully utilised in the furtherance of his hobby.

## 99 TEST EQUIPMENT PROJECTS YOU CAN BUILD TAB No.805 \$16.45

An excellent source book for the hobbyist who wants to build up his work bench inexpensively. Projects range from a simple signal tracer to a 50MHz frequency counter. There are circuits to measure just about any electrical quantity: voltage, current, capacitance, impedance and more. The variety is endless and includes just about anything you could wish for!

## HOW TO GET THE MOST OUT OF LOW COST TEST EQUIPMENT AB017 \$10.45

Whether you want to get your vintage 1960 'TestRite' signal generator working, or you've got something to measure with nothing to measure it with, this is the book for you. The author discusses how to maximize the usefulness of cheap test gear, how to upgrade old equipment, and effective test set ups.

## THE POWER SUPPLY HANDBOOK TAB No.806 \$16.45

A complete one stop reference for hobbyists and engineers. Contains high and low voltage power supplies of every conceivable type as well mobile and portable units.

## PH246: ELECTRONIC TEST EQUIPMENT \$20.45

Covers analog and digital meters, oscilloscopes, frequency generation and measurement, and special measuring instruments.

## Tab1532: THE COMPLETE BOOK OF OSCILLOSCOPES \$20.45

This totally up-to-date handbook is both an in-depth reference source and a practical applications guide. Information is included on both ordinary service and laboratory scopes, waveform analysis, vectors, vectorscopes, high and low frequency analysis, sampling, storage, digital scopes, and signature analysis. The author, Stan Prentiss is one of the leading technical writers in the U.S.

## INTERRELATED INTEGRATED ELECTRONICS CIRCUITS FOR THE RADIO AMATEUR, TECHNICIAN, HOBBYIST AND CB'ER MENDELSON \$11.45

This book provides a variety of appealing projects that can be constructed by anyone from the hobbyist to the engineer. Construction details, layouts, and photographs are provided to simplify duplication. While most of the circuits are shown on printed circuit boards, every one can be duplicated on hand-wired, perforated boards. Each project is related to another project so that several may be combined into a single package. The projects, divided into five major groups, include CMOS audio modules, passive devices to help in benchwork, test instruments, and games.

## BASIC CARRIER TELEPHONY, THIRD EDITION TALLEY \$16.45

A basic course in the principles and applications of carrier telephony and its place in the overall communications picture. It is abundantly illustrated, with questions and problems throughout, and requires a minimum of mathematics.

## Tab1309: THE ACOUSTIC AND ELECTRIC GUITAR REPAIR HANDBOOK \$25.00

Literally everything the amateur or professional musician needs to know to properly maintain his instruments, plus all the how-to's for making repairs from simple tuning to major overhauls.

## BP110: HOW TO GET YOUR ELECTRONIC PROJECTS WORKING R.A. PENFOLD \$8.10

We have all built circuits from magazines and books only to find that they did not work correctly, or at all, when first switched on. The aim of this book is to help the reader overcome just these problems by indicating how and where to start looking for many of the common faults that can occur when building up projects.

## ELECTRONIC TROUBLESHOOTING HANDBOOK AB019 \$12.45

This workbench guide can show you how to pinpoint circuit troubles in minutes, how to test anything electronic, and how to get the most out of low cost test equipment. You can use any and all of the time-saving shortcuts to rapidly locate and repair all types of electronic equipment malfunctions.

## COMPLETE GUIDE TO READING SCHEMATIC DIAGRAMS AB018 \$10.45

A complete guide on how to read and understand schematic diagrams. The book teaches how to recognize basic circuits and identify component functions. Useful for technicians and hobbyists who want to avoid a lot of headscratching.

## REFERENCE

## BP85: INTERNATIONAL TRANSISTOR EQUIVALENTS GUIDE \$12.25

ADRIAN MICHAELS

This book will help the reader to find possible substitutes for a popular user-orientated selection of modern transistors. Also shown are the material type, polarity, manufacturer selection of modern transistors. Also shown are the material type, polarity, manufacturer and use. The Equivalents are sub-divided into European, American and Japanese. The products of over 100 manufacturers are included. An essential addition to the library of all those interested in electronics, be they technicians, designers, engineers or hobbyists. Fantastic value for the amount of information it contains.

## BP108: INTERNATIONAL DIODE EQUIVALENTS GUIDE \$8.35

ADRIAN MICHAELS

This book is designed to help the user in finding possible substitutes for a large user orientated selection of the many different types of semiconductor diodes that are available today. Besides simple rectifier diodes also included are Zener diodes, LEDs, Diacs Triacs, Thyristors, Photo diodes and Display diodes.

## BP1: FIRST BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES \$2.80

B.B. BABANI

This guide covers many thousands of transistors showing possible alternatives and equivalents. Covers transistors made in Great Britain, USA, Japan, Germany, France, Europe, Hong Kong, and includes types produced by more than 120 different manufacturers.

## BP14: SECOND BOOK OF TRANSISTOR EQUIVALENTS AND SUBSTITUTES \$4.80

B.B. BABANI

The "First Book of Transistor Equivalents" has had to be reprinted 15 times. The "Second Book" produced in the same style as the first book, in no way duplicates any of the data presented in it. The "Second Book" contains only additional material and the two books complement each other and make available some of the most complete and extensive information in this field. The interchangeability data covers semiconductors, manufactured in Great Britain, USA, Germany, France, Poland, Italy, East Germany, Belgium, Austria, Netherlands and many other countries.

## TOWER'S INTERNATIONAL OP-AMP LINEAR IC SELECTOR TAB No.1216 \$13.45

This book contains a wealth of useful data on over 5,000 Op-amps and linear ICs — both pinouts and essential characteristics. A comprehensive series of appendices contain information on specs, manufacturers, case outlines and so on.

## CMOS DATABASE \$9.95

TAB No.984

There are several books around with this title, but most are just collections of manufacturers' data sheets. This one, by Bill Hunter, explains all the intricacies of this useful family of logic devices. ... the missing link in getting your own designs working properly. Highly recommended to anyone working with digital circuits.

## Tab1538: ELECTRONIC DATABASE — 3RD EDITION \$30.00

Any electronic job will be easier and less time consuming when you have instant access to exactly the nomogram, table, chart or formula you need, when you need it. All this and much more is included in this completely revised and updated version of one of the most respected information source in the electronics field. Generously indexed, this handbook is divided into six sections: Frequency Data; Communication; Passive Components; Active Components; Mathematical Data; Formulas and Symbols and Physical Data.

## Tab1516: TOWERS INTERNATIONAL MICROPROCESSOR SELECTOR \$31.45

Towers Selector books have gained an international reputation for completeness and usefulness. This volume gives you all the data you will normally need to select the right chip.

## ROBOTICS

## THE COMPLETE HANDBOOK OF ROBOTICS TAB No.1071 \$16.45

All the information you need to build a walking, talking mechanical friend appears in this book. Your robot can take many forms and various options — light, sound, and proximity sensors — are covered in depth.

## HOW TO BUILD YOUR OWN SELF PROGRAMMING ROBOT TAB No.1241 \$14.45

A practical guide on how to build a robot capable of learning how to adapt to a changing environment. The creature developed in the book, Rodney, is fully self programming, can develop theories to deal with situations and apply those theories in future circumstances.

## Tab1421: HANDBOOK OF ADVANCED ROBOTICS \$24.45

Here's the key to learning how today's sophisticated robot machines operate, how they are controlled, what they can do and how you can put this modern technology to work. Also included are details on building your own hobby robot.

## BUILD YOUR OWN WORKING ROBOT TAB No.841 \$11.45

Contains complete plans — mechanical, schematics, logic diagrams and wiring diagrams — for building Buster. Buster is a sophisticated experiment in cybernetics you can build in stages. There are two phases involved: first Buster is leashed, dependent on his creator for guidance; the second phase makes Buster more independent and able to get out of tough situations.

## VIDEO

## BP100: AN INTRODUCTION TO VIDEO D.K. MATHEWSON \$8.10

Presents in as non-technical a way as possible how a video recorder works and how to get the best out of it and its accessories. Among the items discussed are the pros and cons of the various systems, copying and editing, international tape exchange and understanding specifications.

## Tab1519: ALL ABOUT HOME SATELLITE TELEVISION \$23.45

Covers such aspects as where to buy, problems in setting up your TVRO station and how to solve them, antenna siting and equipment selection.

## Tab1490: VIDEO CASSETTE RECORDERS: BUYING, USING AND MAINTAINING \$14.45

A complete handbook for the video enthusiast. You'll learn about how the systems work and how to choose as well as take a technical look at the inside workings. There are also sections on making your own video recordings.

## MISCELLANEOUS

## BP101: HOW TO IDENTIFY UNMARKED IC'S \$2.70

K.H. RECORR

Originally published as a feature in 'Radio Electronics', this chart shows how to record the particular signature of an unmarked IC using a test meter, this information can then be used with manufacturer's data to establish the application.

## AUDIO AND VIDEO INTERFERENCE CURES KAHANER \$9.45

HB21

A practical work about interference causes and cures that affect TV, radio, hi-fi, CB, and other devices. Provides all the information needed to stop interference. Schematic wiring diagrams of filters for all types of receivers and transmitters are included. Also, it supplies simple filter diagrams to eliminate radio and TV interference caused by noisy home appliances, neon lights, motors, etc.

## BASIC TELEPHONE SWITCHING SYSTEMS TALLEY \$16.00

HB27

The Revised Second Edition of this book, for trainee and engineer alike, includes updated statistical data on telephone stations, and new and improved signaling methods and switching techniques. It also includes E & M signaling interface for electronic central offices and automatic number identification methods used in step-by-step, panel and crossbar central offices.



# Playmate Part II



**For aspiring artists we conclude our portable guitar amp with added ingredients fuzz and wah. Design and development by Phil Walker.**

BEFORE WE CONTINUE with our analysis of the circuit theory, we have to apologize for the manpower shortage last month which meant that the Playmate circuit diagram missed out on our usual thorough checking. Naturally the perversity of the universe ensured that this was the project that had several errors, so we're reprinting the circuit diagram with mistakes and duplicate component numbers corrected and all pots marked CW or CCW to tie up with the front panel wiring diagram. Meanwhile, back to the plot . . .

## The State-variable Filter

Things start getting a bit heavy now! The following equations are the transfer equations for a state-variable filter such as that in Fig. 2:

$$V_x = [(R1/R3) \times V_{in} + (R2/R3) \times V_y] + R5/(R4 + R5) \times [1 + R3(R1 + R3)/(R1R2)] \times V_o$$

If  $R1 = R2 = R3 = R5$ , then:

$$V_x = -(V_{in} + V_y) + R1(1 + 2)/(R4 + R1) \times V_o$$

$$V_x = \frac{3R1V_o}{R4 + R1} - (V_{in} + V_y)$$

$$V_o = -1/sCR \times V_x$$

$$V_x = -sCR V_o$$

$$V_y = -1/sCR \times V_o$$

Substitute (2) and (3) in (1):

$$-sCR V_o = \frac{3R1 V_o}{(R1 + R4)} - (V_{in} + (-1/sCR V_o))$$

$$\frac{V_{in}}{V_o} = (sCR + 3R1/(R1 + R4) + 1/sCR)$$

$$= j\omega CR + \frac{3R1}{(R1 + R4)} + 1/j\omega CR$$

$$(s = j\omega, \omega = 2\pi f, f = \text{frequency})$$

Compare this with the equation for an LCR tuned circuit:

$$V_{in} = (j\omega L + 1/(j\omega C) + R) I_{out} \quad (\text{Fig. 3})$$

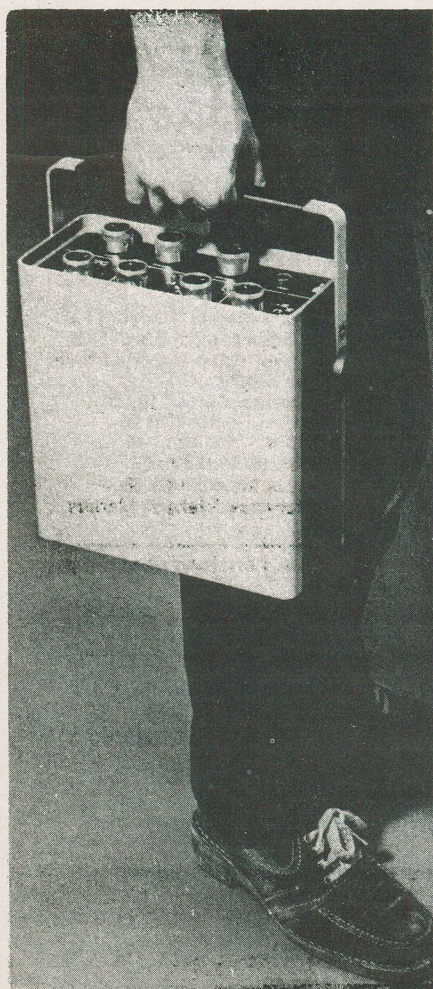
$$\frac{V_{in}}{I_{out}} = j\omega L + R + 1/(j\omega C) \quad (\text{LCR circuit})$$

$$\frac{V_{in}}{V_{out}} = j\omega CR + \frac{3R1}{(R1 + R4)} + 1/(j\omega CR)$$

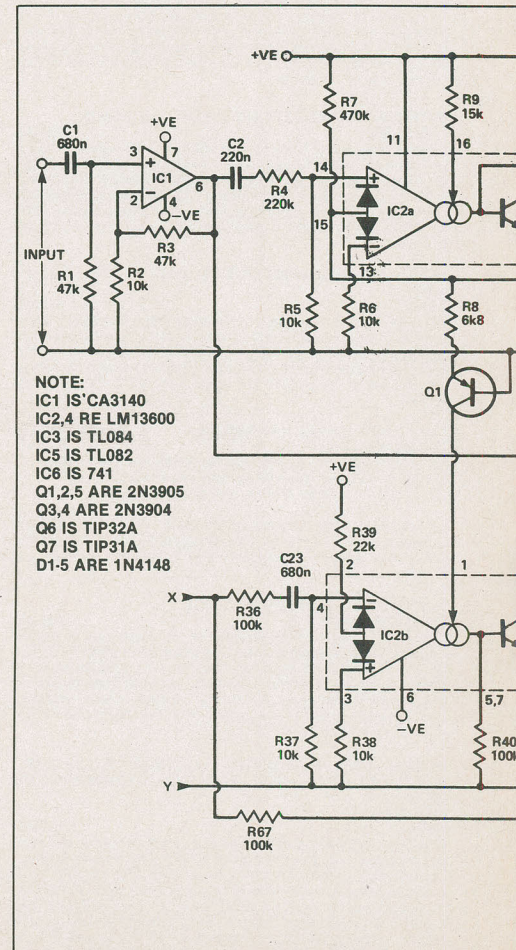
(State variable filter)

From this it is apparent that these responses are similar except that the LCR circuit gives a current output rather than a voltage. For this type of LCR circuit, the frequency of minimum attenuation or maximum gain (the resonant frequency) is given by:

$$f = \frac{1}{2\pi\sqrt{LC}}$$



**Fig. 1. (Right) The correct version of the circuit diagram — sorry ...**





For our circuit this is: —

$$\frac{1}{2\pi\sqrt{CR \cdot CR}} = \frac{1}{2\pi CR}$$

The 'Q' factor influencing the bandwidth is given by:

$$Q = \frac{2\pi f L}{R} = \frac{2\pi \times (1/2\pi CR) \times CR}{R} = \frac{3R1/(R1 + R4)}{3R1}$$

Figure 4 shows the configuration necessary to use the LM13600 as a filter of this type. Last month we found that the transfer function of the LM13600 with no diode current is given by:

$$I_{out} = \frac{I_{abc}}{26 \times 10^{-3}} \times V_{in}$$

As we are using a capacitive load, this output current will generate a voltage of:

$$V_{out} = I_{out} \times \frac{1}{j\omega C} = V \times \frac{I_{abc}}{26 \times 10^{-3}} \times \frac{1}{j\omega C} = V_{in} \frac{R1}{R1 + R} \times \frac{I_{abc}}{26 \times 10^{-3}} \times \frac{1}{j\omega C}$$

Since we are not dealing with a normal type of op-amp, analysis of the circuit is not as easy as the normal filter, but the result is an equation of much the same form. We do not show all the derivation here as it would occupy most of a page. However, the end result is that the centre frequency of the filter pass band is proportional to the amplifier bias current. Therefore we have an easy way to control the wah wah effect.

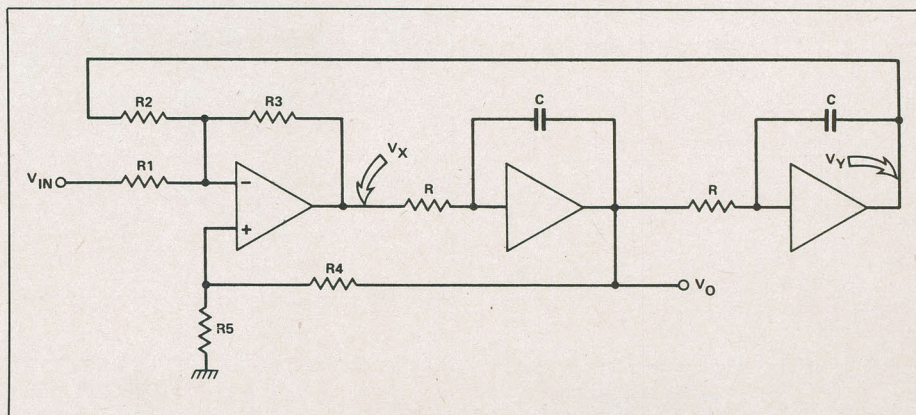
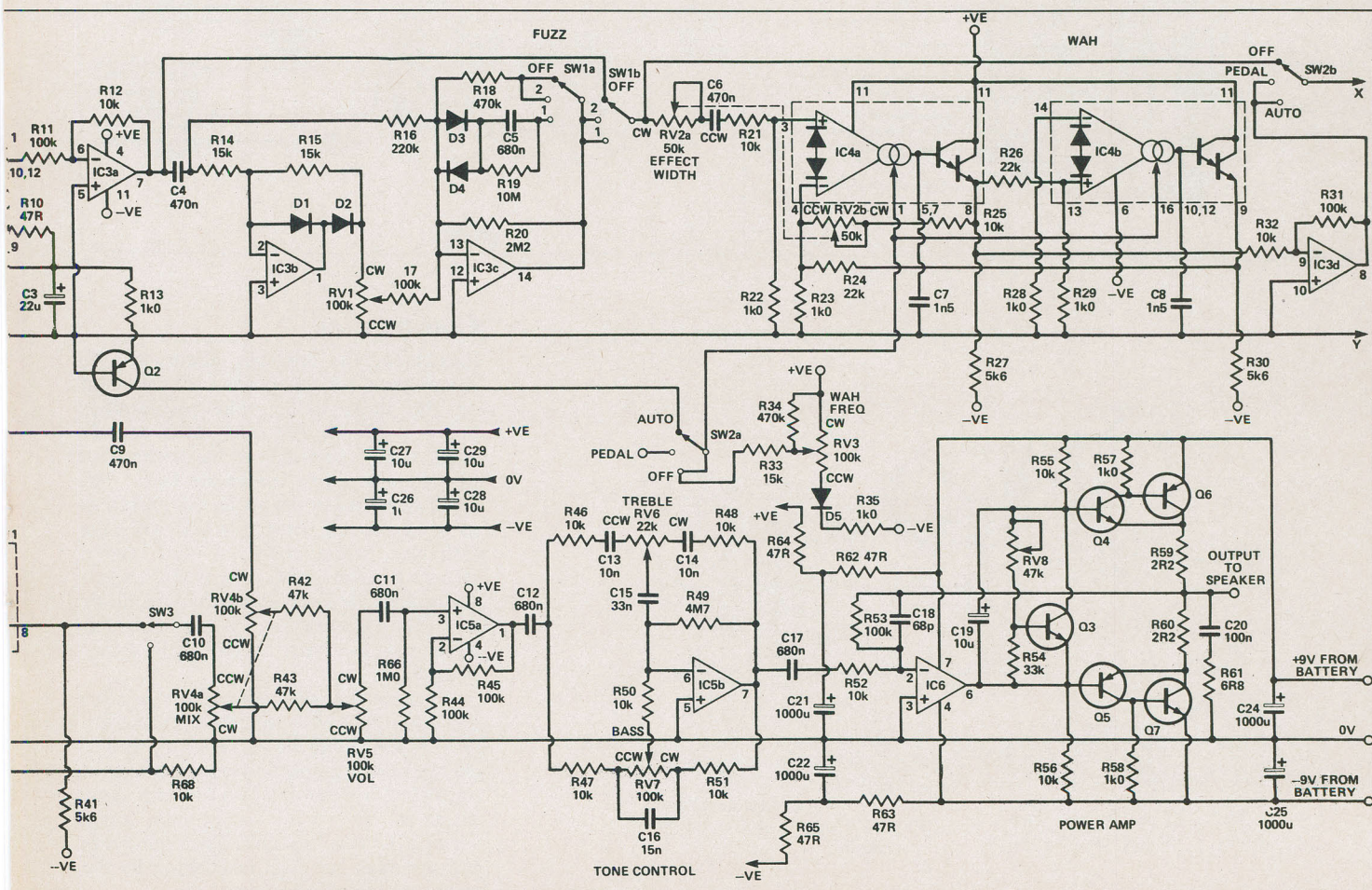


Fig. 2. Generalized state-variable filter.





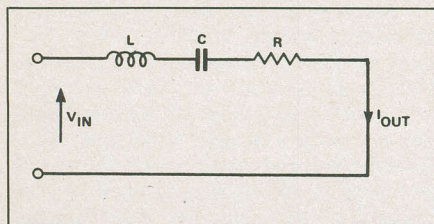
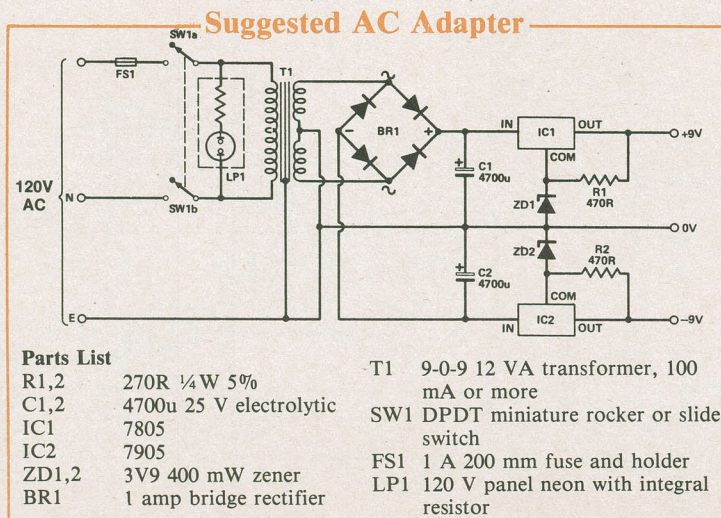
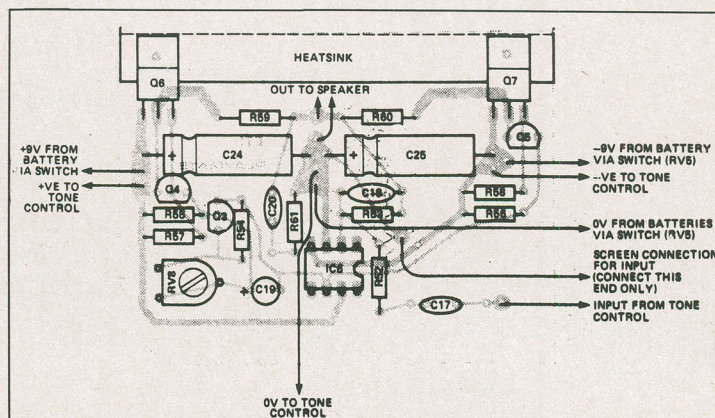
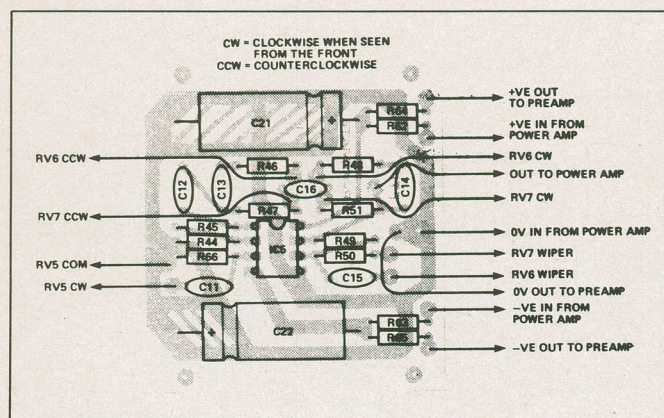
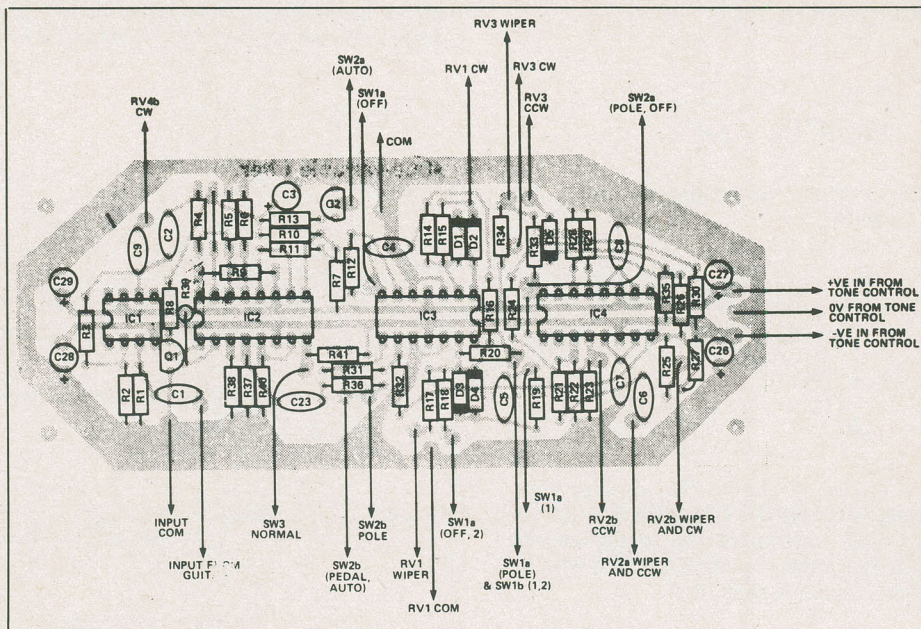


Fig. 3. Generalized LCR tuned circuit.

Fig. 5. (Right) Component overlay for the pre-amplifier board.

Fig. 6. (Below) Overlay for the tone control board.

Fig. 7. (Far Right) Overlay for the power amp of the Playmate.



## Construction

Except for the controls, almost all the components for this project are mounted on the three PCBs. The preamplifier board is the largest and most densely packed. It is advisable to use sockets for the ICs and don't forget the links. The capacitors used in the project should be as small as possible, otherwise you will have difficulty fitting them. A fine tipped soldering iron will be useful when assembling the boards and care should be taken to avoid creating short circuits between tracks with accidental solder splashes.

Ensure that all the diodes, transistors and other polarized components (especially IC3) are fitted the correct way round. On the power amplifier board the output transistors are mounted on top of a short length of 1/2" x 1/2" aluminum angle which acts as a heatsink. The transistors and the angle are held in position by the transistor mounting screws.



## PARTS LIST

### Resistors (All 1/4 W 5%)

R1,3,42,43	47k
R2,5,6,	
12,21,25,	
32,37,	
38,46-48,	
50-52,55,	
56,68	10k
R8	220k
R7,18,34	470k
48	6k8
R9,14,15,33	15k
R10,62-65	47R
R11,17,31,	
36,40,44,	100k
45,53,67	
R13,22,23,	
28,29,35,	
57,58	1k0
R19	10M
R20	2M2
R24,26,39	22k
R27,30,41	5k6
R49	4M7
R54	33k
R59,60	2R2
R61	6R8
R66	1M0

### Potentiometers

RV1,3,7	100k linear
RV2	50k linear dual gang
RV4	100k linear dual gang
RV5	100k logarithmic with two-pole switch
RV6	22k linear
RV8	47k miniature horizontal preset

### Capacitors (All polycarbonate except where stated)

C1,5,10-12	
17,23	680n
C2	220n
C3	22u 16 V tantalum
C4,6,9	470n
C7,8	1n5
C13,14	10n
C15	33n
C16	15n
C18	68p
C19	10u 35 V tantalum
C20	100n
C21,22,24,	
25	1000u 10 V axial electrolytic
C26-29	47u 10 V PCB electrolytic

### Semiconductors

IC1	CA3140
-----	--------

IC2,4	LM13600
-------	---------

IC3	TL084
IC5	TL082
IC6	741
Q1,2,5	2N3905 or equiv.
Q3,4	2N3904 or equiv.
Q6	TIP32 or equiv.
Q7	TIP31 or equiv.
D1-5	1N4148

### Miscellaneous

SW1,2	2-pole, 3-way miniature slide switch
SW3	1-pole, 2-way miniature slide switch

PCBs; case (220 x 105 x 230mm), Vero Ref. 75-2443A; wire (single, single screened and double screened); 4" or 5" loudspeaker (8 ohms, 5 W); standard 1/4" jack socket for input; stereo jack socket for foot switch (if required); 75 mm or 12 x 12 mm aluminum angle; two 9V batteries and clips.

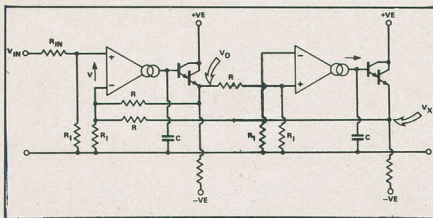
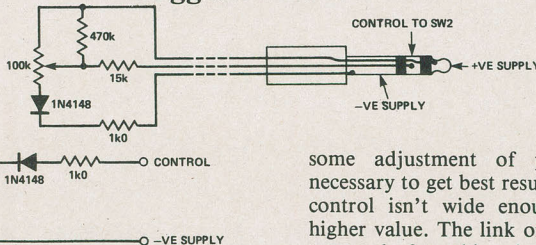


Fig. 4. Using the LM13600 as a state-variable filter.

## Suggested Foot Pedal



The first diagram shows the circuit used with a three-connection (stereo) jack. This will duplicate the effect of the panel-mounted control. As the angular rotation of foot pedal controls is sometimes limited,

some adjustment of position may be necessary to get best results. If the range of control isn't wide enough, change to a higher value. The link on SW2a should be removed for this circuit. The second diagram shows a simple circuit for use with ordinary jack connectors which can be used if the link between SW2a pole and off position is retained.

Mount the control switches and potentiometers on the front panel (see photo for our layout) and make the necessary interconnections and fit the three components needed around the balance control. The wiring from the front panel to the preamplifier/effects and the tone control boards should be carried out using thin flexible wire for control signals and miniature screened cable for any sound signals. These should be short, but allow enough slack to be able to fit them in position easily (it is probably easier to connect all the wires to the circuit boards first). The power amplifier board was fitted to the metal base plate of our case using the angle on which the transistors were mounted. It was positioned so that it fitted neatly between the two batteries in the bottom of the case. Together with the loudspeaker, the amplifier board holds the batteries without any further help.

The small loudspeaker for this project was mounted on the plastic case of the box through which a number of holes were drilled to let the sound out. If required, a small mains power unit capable of 9-0-9 V at 100 mA or more may be used to power the unit.

A foot pedal control for controlling the wah wah effect could be plugged into a jack socket. This would need to be one of the three-connection or stereo type so that positive and negative supplies as well as the control signal could be connected.

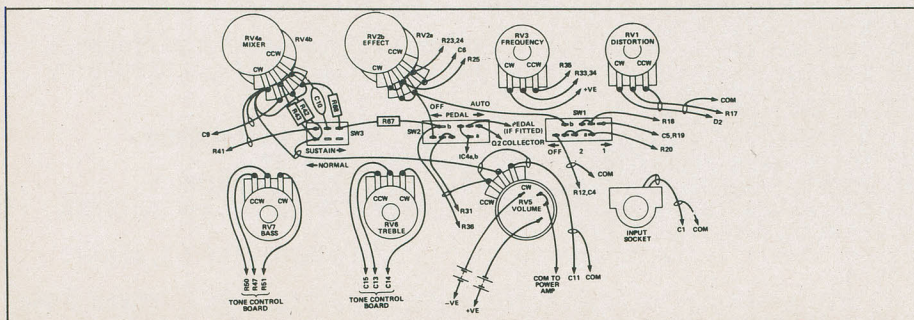


Fig. 8. How to wire the front panel. Compare with the front panel photo last month.

ETI



# COMPUTING TODAY

## VIC-20 High Res Graphics

J. Ennis

The recommended way to create high-res graphics on the VIC-20 is to bit-map as much of the screen as you have memory for. But even with memory expansion cartridges, the maximum size is about 160 by 160 pixels because character memory cannot be located in the expansion cartridge.

The following program does not try to bit-map the entire screen, so it avoids this limitation. When plotting graphs and the like, only a small portion of the screen is actually used.

To turn on a single pixel, the program PEEKs into screen memory at the place the pixel will appear when it is plotted. If the character there is a space, it POKES another character in its place and then POKES into character memory to turn on a single dot within that character.

Thus, when a graph is plotted, most of the screen is filled with spaces and the remainder with other characters.

Within the program the plotting of points on the screen is achieved by two machine-language routines which must be POKED into memory before running. The first of these clear out the character memory in RAM, sets the character memory pointer to 5120 (decimal), clears the screen and sets the 8116 character size.

The second routine plots a point whose x and y co-ordinates are stores in locations 0 and 1 respectively. Both routines are re-locatable but only work on the unexpanded VIC-20, although they could be modified.

Type in Program 1 and save it immediately, taking special care with the data statements; a mistake there may well crash the program later. Erase the first program, then type in Program 2 and save it on tape immediately after Program 1.

To use it, load and run Program 1, which POKES the machine language into memory; unless there is a mistake, it will then automatically load and run the second program on the tape, the one that does the plotting.

When run as above, the second program will plot the graph, in Cartesian co-ordinates, of a function defined in line 5. To do this, it will ask for the domain of the function, i.e.: the range of values on the

x-axis for which values of the function are to be plotted.

It will then ask for the plotting density, i.e.: how close together it will plot the points, where 1 gives the highest density and 4 the lowest.

Once plotted, the graph will remain on the screen until the user presses the CTRL key and then the space bar.

Both parts of the program should be typed in without any spaces between words as this saves using too much memory space.

### MACHINE-LANGUAGE GRAPHICS

#### Program 1

```
10 REM LOADS MACHINE-LANGUAGE
20 CH=0:FORI=5892TO6119: EADA:POKEI,A:CH=CH+A:NEXT:IFCH<>33481
THENPRINT"ERROR":END
30 FORI=5892TO6119:POKEI-1000,PEEK(I):NEXT:POKE631,131:POKE
198,1:END
40 DATA173,3,144,9,1,141,3,144,169,8,141,15,144,169,253,141,5,
144,169,147,32,210,255
50 DATA169,0,133,251,169,30,133,252,169,150,160,0,145,251,200,
192,0,208,249,230,252,165
60 DATA252,201,32,208,237,169,20,133,252,169,0,133,251,160,0,
145,251,200,192,0,208,249
70 DATA230,252,165,252,201,30,208,235,96,169,0,133,251,133,252,
133,253,133,254,165,0
80 DATA24,105,248,230,251,176,249,198,251,165,1,24,105,240,230,
252,176,249,198,252,166
90 DATA252,169,0,24,105,22,202,224,0,208,248,24,101,251,133,253
164,253,185,0,30,201
100 DATA150,208,9,173,255,29,153,0,30,238,255,29,133,253,165,1,
166,252,56,233,16,202
110 DATA208,250,133,254,169,20,133,3,165,254,166,253,24,105,
16,144,2,230,3,202,224,0
120 DATA208,244,133,2,165,0,166,251,56,233,8,202,224,0,208,248,
133,252,169,7,56,229
130 DATA252,170,169,1,24,133,251,101,251,202,224,0,208,246,133,
252,201,0,208,2,230,252
140 DATA160,0,177,2,5,252,145,2,96
```

#### Program 2

```
5 DEFNNA(X)=SIN(X)
10 POKE36878,9:PRINTCHR$(147)SPC(48)"VIC GRAPHICS":PRINTSPC(90)
:INPUT"DOMAIN(A,B)":A,B
20 IFA>=BTHENPRINTSPC(50)"ERROR":POKE36876,200:FORI=0TO1500
:POKE36876,0:GOTO10
30 PRINTSPC(45):INPUT"PLOT DENSITY(1-4)":C:IFC<1ORC>4THENC=4
40 SYS4892:POKE7679,1:D=C*(B-A)/175:U=0:L=0:FORI=ATOBSTEPD:C=
FNA(I):IFC<LTHENL=C
50 IFC>UTHENU=C
60 NEXT:H=175/(ABS(L)+U):W=175/(B-A):IFB<0 ORA>0THEN80
70 POKE0,-A*W:FORI=0TO175:POKE1,I:SYS4968:NEXT
80 POKE1,175-ABS(L)*H:FORI=0TO175:POKE0,I:SYS4968:NEXT
90 FORI=ATOBSTEPD:C=FNA(I):X=(I-A)*W:Y=175-(ABS(L)+C)*H:POKE
0,X:POKE1,Y:SYS4968:NEXT
95 POKE36875,180:FORT=0TO600:NEXT:POKE36875,0:WAIT653,4:WAIT
197,32
100 POKE36879,27:POKE36869,240:POKE36867,PEEK(36867)AND254:POKE
198,0:GOTO10
```



**CONGRATULATIONS**  
YOU HAVE JUST BOUGHT YOURSELF  
A PERSONAL MICROCOMPUTER

**NOW WHAT?**

**WE HAVE THE ANSWER!**

## I & S SOFTWARE LIBRARY

OFFERS 3 GREAT WAYS  
TO BUY YOUR FAVOURITE PROGRAMS

**1** I & S SOFTWARE LIBRARY CLUB is the only way to choose the right program for your applications. Try your favourite program at your home for ONE WEEK. If you decide to buy, you pay only the low member's price, if not, simply return it and owe nothing. It is that simple.

**2** SOFTWARE OF THE MONTH CLUB offers you the lowest price and the newest software. You can build your library and save money too. Savings range from 40% or more off the manufacturer's retail price, usually 25% to 35%. **NO** obligation to buy. **NO** automatic shipment. **FREE** club brochure for the first year.

**3** Our **TRUE MAILORDER PRICES** are the lowest in Canada. We will beat or meet any nationally advertised price or the difference will be refunded.

### WE HAVE PROGRAMS FOR:

- APPLE • ATARI • COMMODORE 64 • IBM PC
- SINCLAIR ZX81 • TRS80 I/III •
- TRS80 COLOUR • VIC 20 •

These services are available by mail order only.  
For more information write or call to:



**I & S SOFTWARE LIBRARY, Inc.**  
#12, 10015 - 82 Avenue, Edmonton, Alberta T6E 1Z2  
(403) 435-2923

Circle No. 40 on Reader Service Card.

## Complete System

only **\$995.00**



### INCLUDES:

- Disk Drive
- Controller
- Green Monitor
- 48K Computer
- Fully Apple™ II Compatible
- 90 Day Warranty

## HEAVY DUTY

Switching Power Supply  
For Apple II™ **\$99.00**

**Electronic Control Systems**  
1890 Meyerside Drive  
Mississauga, Ontario  
L5T 1B4  
**(416) 673-1302**

Hours — Mon to Fri 9-7  
Sat 9-1

## Printers

Gemini 10X printer ..... \$375.00  
Gemini 15 printer ..... \$645.00  
Epson RX-80 ..... \$499.00  
EPSON MX-80 ..... \$699.00  
TTX 15" Daisy Wheel ..... \$875.00

## Disk Drive

Apple™ compatible, 5 1/4" ..... \$275.00

## Monitors

COMREX 13" high res.  
amber ..... \$249.00  
COMREX 13" high res.  
colour ..... \$499.00  
AMDEK Colour ..... \$499.00  
ECS 13" high res. .... \$169.00

## Cards

80 Column Card ..... \$89.95  
Drive Card ..... \$58.95  
Z80 Card ..... \$69.95  
16K RAM Card ..... \$59.95  
6502 Motherboard (bare) ..... \$29.95  
Any (bare) Card ..... \$ 9.50  
Memorex 5 1/4" disk (box of 10) .. \$28.99  
Complete Kit  
(6502 Main Board) ..... \$190.00

(a) Keyboard with U/L case  
characters and numeric keypad

**\$99.00**

(b) ABS case with numeric pad  
only **\$79.00**

(c) Both (a) & (b) **\$175.00**

IBM Compatible Board,  
Tested and Assembled  
**\$699.00**

Circle No. 32 on Reader Service Card.



# Active Components

**NUMBER ONE IN  
QUALITY  
SERVICE  
AVAILABILITY**

**THE WORLD'S MOST  
COMPLETE PROFESSIONAL  
AND HOME ELECTRONICS  
ENTHUSIAST INVENTORY**

- \* Semiconductors + Memories
- \* Microprocessors + Support Circuits
- \* Microcomputer Systems + Peripherals
- \* Passive Electronic Components
- \* Hand Tools, Wire Wrapping,  
Soldering Equipment + Hardware

**NOW AVAILABLE — FREE  
1983 80-page catalogue**

A complete listing of products  
and specifications

Call, write or circle the  
inquiry card for your  
free copy today.

**MONTREAL**  
5651 rue Ferrier  
Montreal, Quebec  
H4P 2K5  
(514) 731-7441

**TORONTO**  
14 Carlton Street  
Toronto, Ontario  
M5B 1K5  
(416) 977-7692

**DOWNSVIEW**  
4800 Dufferin St.  
Downsview, B.C.  
M3H 5S8  
(416) 661-1115

**OTTAWA**  
Baxter Centre  
1050 Baxter Road  
Ottawa, Ontario  
K2C 3P2  
(613) 820-9471

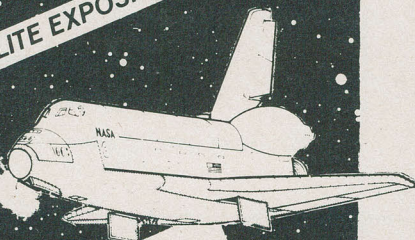
**CALGARY**  
5809 MacLeod Tr. S.  
Unit 109  
Calgary, Alberta  
T2H 0J9  
(403) 259-6437

**VANCOUVER**  
3070 Kingsway  
Vancouver, B.C.  
V5R 5J7  
(604) 438-3321

Circle No. 2 on Reader Service Card.

**FIRST CANADIAN SATELLITE EXPOSITION**

**FEBRUARY 3, 4, 5, 1984**



A three day exposition at Vancouver's Delta River Inn featuring seminars, lecturers, wholesale distributors, leading manufacturers and more. All aspects of the Satellite Industry will be represented. To assure your place among the front runners in the field reserve now. The First Canadian Satellite Show.

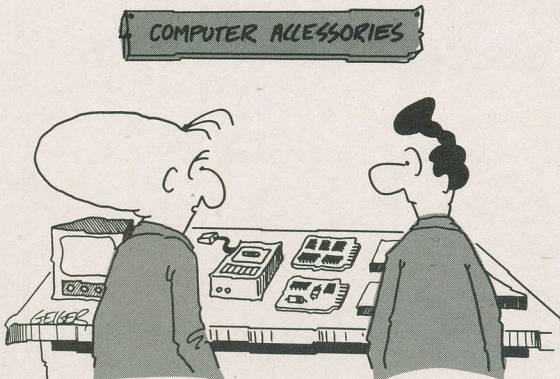
■ Distributor of First Canadian Satellite TV Guide:  
**GALAXY GUIDE**  
■ Information for the First Canadian Satellite Expo  
booths available now

HOSTED BY  
**GALAXY GUIDE**  
6830 PALM ST., BURNABY, B.C., CANADA V5J 4M3  
OR PHONE (604) 430-4040

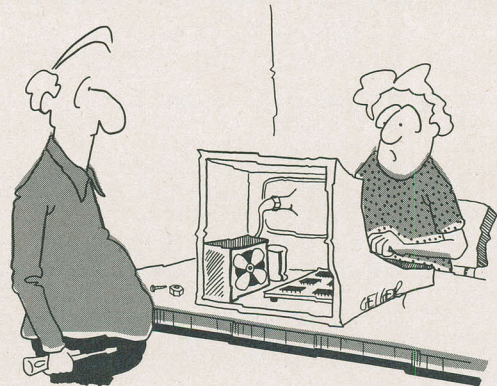
Circle No. 9 on Reader Service Card.



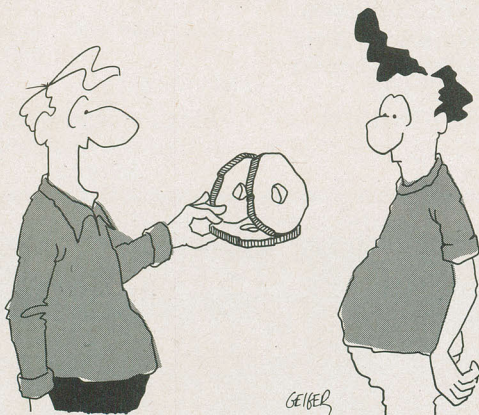
# The Fun of Electronics



"Buy the memory expansion kit. It's a good deal."



"He says he likes the new fan, but would have preferred slave girls waving palm leaves."



"It's here at last! The triple-side, double-density diskette."



"It's really quite effective — though the little fellas squirm a lot when you try to strap them in."



"Don't tell me ... it's a light pen."



"That's really amazing. I remember when those mainframe computers were as big as footballs."



# Electronics Today

INTERNATIONAL

**AT YEAR END WE SAY THANK YOU TO READERS  
AND ADVERTISERS. YOU HAVE MADE ELECTRONICS  
TODAY NUMBER ONE IN EVERY WAY.**

**Month-by month ABC circulation**



**ADVERTISING INFORMATION  
(416) 423-3262**

**SUBSCRIPTION INFORMATION  
(416) 423-3263**

**Sincerely,**

*Halvor Moorshead*  
**Publisher.**

## **A proven success!**



# Book Review

## Mathematics for Electricity/Electronics

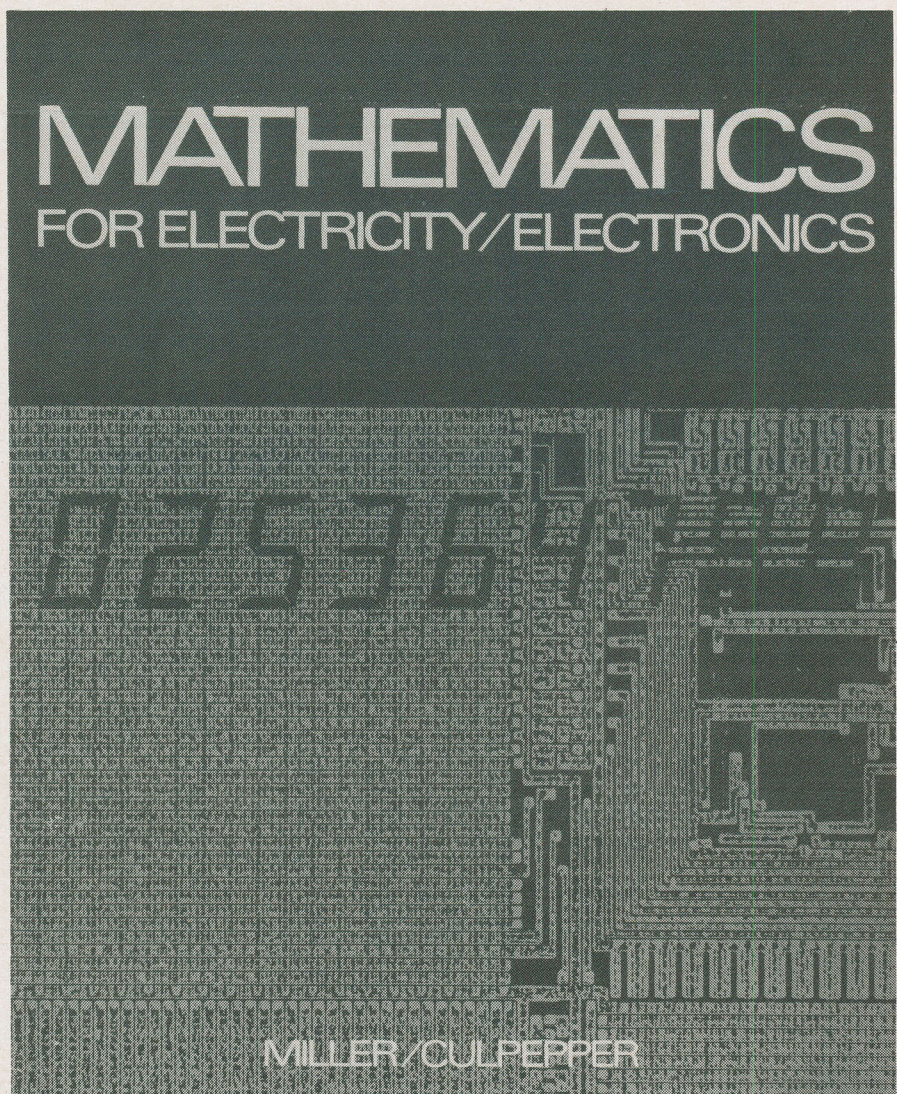
Miller/Culpepper, Collier MacMillan Canada Ltd., ISBN 0-02-818220-0. Paperback. **ALTHOUGH THIS** book is intended for use in an electronics course, it's an excellent choice if you'd like a reference book of basic information and equations. For instance, who can remember Delta-Wye transforms unless you use them daily? With this handy manual, you have the information you need, and wonder of wonders, it's all easy to find, thanks to excellent layout.

The book is divided into 30 chapters, or units. Each unit consists of an introduction to the basic topic, relevant tables and test problems for the eager. The main formulas are placed in boxed inserts for readability. The answers to the tests, unfortunately, are in a softbound book which must be purchased separately; after all, it's meant to end up in classrooms, and we can't have people peeking.

Taking the first unit, Resistance, as an example of the format, you'll find a one-page discussion of the various factors affecting the resistivity of conductors. Two pages of tables and examples follow; the tables include the determination of the resistance of a material given the dimensions, the effects of temperature, and standard wire gauges. The examples are expertly concocted by someone who has the rare ability to put himself in the place of the information-seeker. Seldom-used terms are neatly explained. There is a lack of metric units, for which some may breathe a sigh of relief, but naturally the book's largest market would be in the U.S.

Problems accompanying each unit are of a practical nature; they describe the sort of situations one might be expected to find outside the classroom: for instance, finding the resistance of an electric clock coil given the length, wire, and temperature. You may rarely need to know about clock coils, but if you wind any type of coils, say, speaker crossovers, you can appreciate the practicality of the approach.

Unit 2 applies resistivity using Ohm's Law. Three examples are given, along with 25 questions. Interestingly, the authors give the old high school rule-of-thumb for remembering the Law: divide a pie into three and cover the unit to be found; the other two are then shown in the proper relationship. The problem with this, as I recall from



high school, is that nobody can ever remember which letters go in which sections of the pie.

The following units cover manipulation of series and parallel resistances, with Unit 6 being particularly excellent at showing how to reduce complex resistor networks to easily useable equivalents. This should give a good grounding for later work in network analysis.

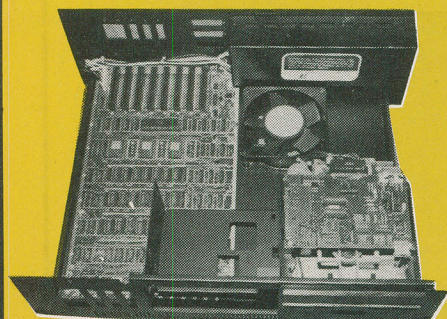
There are units on the basics of meter movements, and the ways to go about turn-

ing them into ammeters, voltmeters, or ohmmeters. Kirchhoff's Laws and series-parallel current flow are covered in a simple but concise manner; the authors have cleverly managed to cram the equivalent of an electronics course into three-page sections. (Quick. What are Kirchhoff's Laws?)

Inductance formulas are given in two units; you can even find formulas for winding your own coils, should you be so eager as to actually do that. I used to pass on building any project that required coil-wind-



## IBM PC™ LOOK-A-LIKE CASE



Make your Apple™ or 6502 machine look like an IBM PC™. This attractive metal case with ABS front bezel looks just like you-know-who, but is punched internally to take all the 6502 Mother boards, power supplies etc that are now sold. Our black beauty power supply fits in just right with the power connector and switch accessible at the right hand side. In addition the case holds 2 standard disc drives (4 slim lines) with all holes pre-punched. There is also a cut-out for a 4 1/4 inch muffin fan inside. Look at the photo, it really looks good

• Keyboard Case ..... \$ 29.95

## UNITRON 2200 CASE



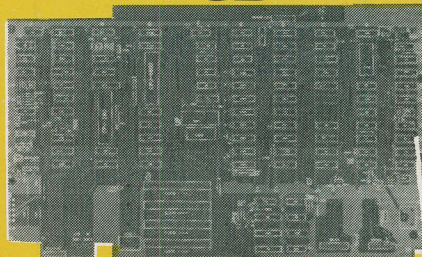
An attractive case and keyboard combination that gives that modern look to your 6502 machine. The case fits the older numeric keyboards and the PCB goes into the case just fine. Comes in an attractive carrying carton. Case and KB case together ..... \$ 89.95

Case only ..... \$ 69.95

KB Case only ..... \$ 29.95

Keyboard and KB case ..... \$119.95

## UNITRON 2200 PCB



A great new PCB, with Z-80, Disc controller, 64K and soft switch on board. Made to run with CPM systems under Z-80 control. Fits into the 2200 case above and use the 2200 KB and case listed. Bare PCB ..... \$ 44.00

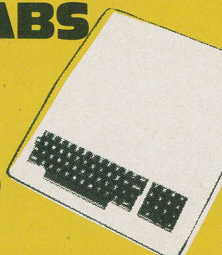
# Parts ELECTRONIC COMPUTER Galore

316 College St., Toronto. M5T 1S3  
(416) 925-1105 (416) 925-8291

**OUR 6502 BOARD**  
Now only \$29.95 still with  
all the versatility of the  
original and a full 8 slots.



**SOLID ABS  
CASE**  
**NUMERIC**  
**\$59.95**  
**STANDARD**  
**\$39.95**



## ASCII KEYBOARDS



Our ASCII keyboards are by ALPS, a famous Japanese switchmaker and feature high quality debounced switches. Full upper and lower case capability. Direct plug in compatible with all 6502 boards and 'SURF' board. Available in numeric and std style.

(a) Standard KB ..... \$89.00  
(b) Numeric KB ..... \$99.00

## POWER SUPPLY



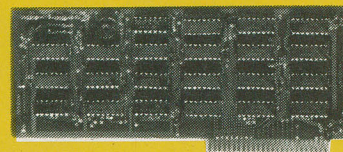
Our Famous "BLACK BEAUTY" power supply, now reduced in price but not in quality. Our ratings are 5V-5A; 12V-2.5A; -5A-1/2A; -12V-1/2A for real. Make sure that any other power supply that lays claim to this rating actually does so. Labels are cheap and we have seen many of the old silver power supplies unchanged except for the label. Easily beats all the rest ..... \$99.95



## SYSTEM SAVIOUR

Hot and getting hotter??? Got an older power supply??? Then you need a SYSTEM SAVIOUR. This is not a religious object, it is a nicely packaged 3 1/2" muffin fan in a molded plastic housing that fits against the slots on the side of our 6502 computer case and draws out the hot air. Widely used by all major political parties, especially the NDP, now at a new low-low price. Complete with 2 grounded 3 wire switched sockets, pilot light, surge protector and on-off switch to turn off your system and two plugged in items. .... \$55.95

## PERIPHERAL CARDS



New low prices.

- A) Z-80 Wired n tested .... \$59.95..Bare PCB .... \$12.95
- B) 80 Col. Wired n tested .... \$74.95..Bare PCB .... \$12.95
- C) 16K Wired n tested .... \$59.95..Bare PCB .... \$12.95
- D) Disc Wired n tested .... \$69.95..Bare PCB .... \$12.95
- E) Shamrock 13/16 sector disk Wired n tested .... \$79.95
- F) Apple™ Prototype card, all WW holes ..... \$12.95
- G) Apple™ Prototype card, power bussed ..... \$14.95
- H) Wildcard™, Wired n tested.\$59.95..Bare PCB \$12.95
- I) 128K Wired n tested, no IC's ..... \$69.95  
With 64K . \$149.94, 128K . \$239.95, PCB \$24.95
- J) IBM PC™ Prototype board, WW only, has a DB-25 footprint and a DB-9 footprint on end for I/O, all the remaining area is WW holes on .1" ..... \$34.95
- K) IBM PC™ Memory prototype board, same as above but a 256K/1024K memory (for 4164 Or 41256 IC's) has been laid out at the inboard end with all the bits bussed as 4 separate banks of 64K/256K with parity and bank select isolated, saves a lot of work in WW memory design. .... \$44.95
- L) IBM PC™ Mother board, a powered 6 slot Mother board that allows the use of our CP I/O 8088 plus our monochrome video/memory board to make a fully IBM compatible system. Note this is a 62 pin bussed Mother board similar to S-100 Mother boards in concept, it thus allows you to plug in any IBM peripheral boards to make your own PC™ clone along with our CPU board. .... \$34.95
- M) IBM PC™ Our newest and most exciting product for the PC™ market. Our designer looked at the past success of the S-100 design and took apart an IBM PC and relaid it out as two standard IBM plug in cards. One is the main CPU with Disk Controller I/O, 8087, 8088, keyboard I/F onboard and the other is a std monochrome video board with 256K of memory. The ROM bios has been completely rewritten so as not to infringe any IBM copyright and since the Basic and DOS are available on the legal market, you can make a fully compatible system that is also fully legal software-wise.  
SEND FOR COMPLETE DETAILS  
Price .... Main CPU board, wired n tested .... \$695.00  
Video board, 64K ..... \$475.00  
128K ..... \$545.00  
192K ..... \$625.00  
256K ..... \$695.00
- N) Power supply, our new power supply is not ready yet, however the black beauty power supply will run a minimum system with 2 standard floppy drives.

## GREAT DEAL



### THE GREAT DEAL CARRIES ON FOREVER AND GETS BETTER

We made an even better buy on over 1000 sets of power supply, 6502 board, numeric keyboard and numeric ABS case (solid coloured ABS All the way through, not just painted plastic) and can now offer the great deal with numeric case and keyboard for the amazing price of ..... \$275.00

along with any 4 of the peripherals listed above as a bare pcb with parts layout. The price is the same for numeric or non-numeric styles of KB and case for this great deal. Please specify numeric or non-numeric when you order, Except 128K, wildcard.

## MAIL ORDERS

We accept; Personal Cheques, Postal Money Orders, Certified Cheques, Travelers Cheques, Visa, American Express, Mastercard, Bank Draft. We ship C.O.D. only by CANPAR and Truck. We do not use Canada Post C.O.D. We will send your goods via CANPAR or Canada Post unless you say otherwise. You will be charged a min \$3.00 for delivery and handling or more if your goods are heavier than the \$3.00 weight or if you specify another delivery service that charges more. All Ont res + 7% sales tax. We sell wholesale to any retail store or other reseller with a sales tax exemption #, as long as a realistic quantity is bought. We ship within a week if in stock and we will cancel any backorders over 4 weeks unless otherwise instructed. 20% Restocking Charge.



# Canada's Personal Computing Magazine

**Computing Now!**  
December 1983

**Spreadsheets**

**INSIDE**

- IBM Clones
- Echo II Review
- Birth of a Dialing Terminal
- Pled Piper Review
- Accounts on a Computer
- And More . . .

Barcode: 57438 70247 12

**December Issue on sale now  
at your newsstand and at 100  
computer and electronic stores  
across Canada**

Save up to 47% by subscribing. One year (12 issues) \$19.95, two years (24 issues) \$34.95. Send to Computing Now! Subscription Department, Suite 601, 25 Overlea Blvd., Toronto, Ontario M4H 1B1.



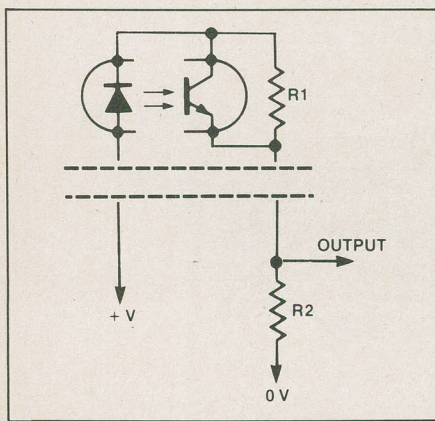
# TECH TIPS

## Two wires for opto-switch F. Arfort

Here's a simple way to run two wires instead of four to a remote opto-switch, as in the case of a wind speed indicator which provides pulses proportional to the rotational speed of a perforated disc.

An opto-coupler consisting of a LED and a phototransistor, either of the packaged variety or made from discrete devices, normally requires four connections. However, twin-pair cable is common, cheap and convenient and it's more economical (and more elegant) to use two wires rather than four for a remote sensor. The further away the sensor may be located from the indicator, the more attractive a two-wire system becomes.

In the circuit, resistor R1 provides a 'starting' current for the LED. Current through R1 and R2 will provide a certain dc level at the output when the path between the LED and phototransistor is blocked. When the path is unblocked, the phototransistor saturates, virtually shorting out R1, thus providing more current through R2, increasing the output dc level. This change can be sensed and used as required.



## Fuse fail indicator R.N. Sinclair

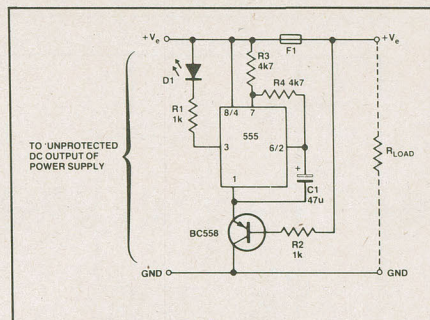
This circuit indicates an open circuit fuse by flashing the LED D1.

The circuit is based around the popular 555 timer IC which is arranged as a multivibrator with its frequency/period determined by C1, R3 and R4. R1 is the current limiter for D1.

When the fuse is intact, the BC558 is off but when the fuse fails and there is an open circuit the BC558 switches on, supplying power to the input of the 555 (pin

1). A load must be present to switch the transistor on and consequently the LED.

The fuse fail indicator must not be used when the power supply is greater than 15 V.



# Affordable Precision

Arkon is now handling the Hitachi line of high-performance digital multimeters. These precision instruments are able to meet the most stringent requirements of both engineer and hobbyist, yet fit comfortably in the palm of the hand and are easily transported.

In addition to these meters, Arkon also carries the complete line of Hitachi scopes and other test equipment by such manufacturers as Hioki and Lutron. In stock as well is a good selection of components including semiconductors and ICs, kits, tools, and manuals. Everything that's needed to get the job done.

Make it a point to drop by soon for a demonstration, or visit us at the Home Entertainment Fair, booth 124, from December 8 to 11.

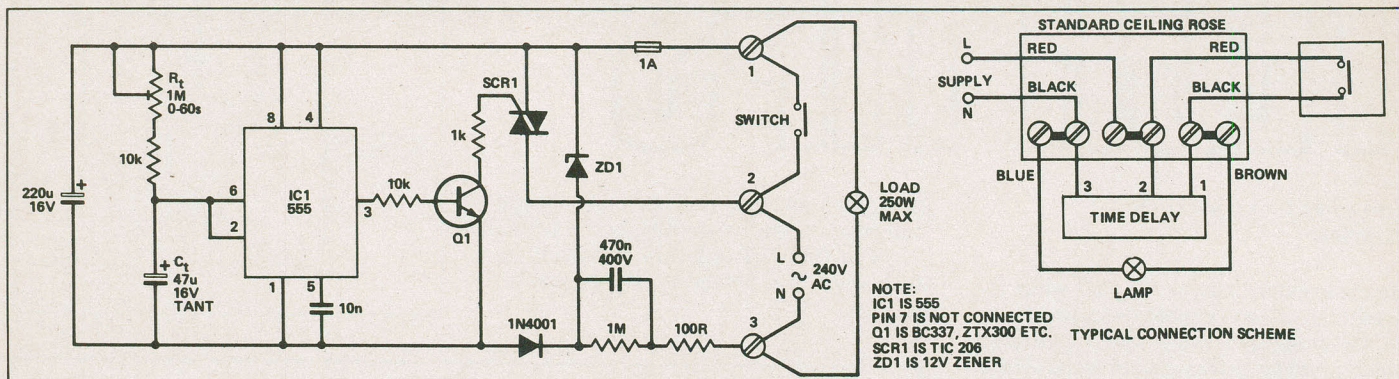


**Hitachi**

**arkon**

Circle No. 5 on Reader Service Card.  
**ARKON ELECTRONICS LIMITED**  
409 QUEEN STREET WEST  
TORONTO M5V 2A5 (593-9653)





### Low-Cost Mains Time-Delay Switch Alex Gray

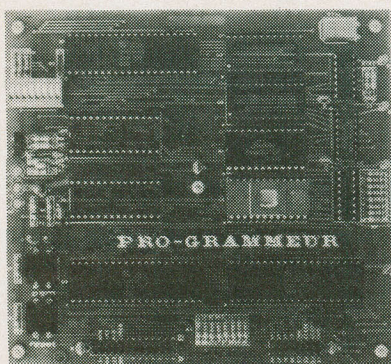
This circuit offers a cheap, reliable replacement for mechanical and pneumatic time-delay switches such as used for corridor lights. It can also be used to protect equipment which is upset by power being applied and removed too rapidly.

When the switch is closed and reopened, the load is switched on for a preset time -  $1.1R_1C$ . During this period, the circuit also switches on its own power. At the end of the time-delay both the load and the circuit are disconnected. In the event of a circuit failure, the push button will still allow the load to be switched on for safety (e.g. in corridor lighting).

If the switch is a normal latching type, the load will be powered as long as the switch is closed, subject to a minimum period. This prevents rapid cycling of the power on and off and may be used to protect equipment susceptible to damage from this situation.

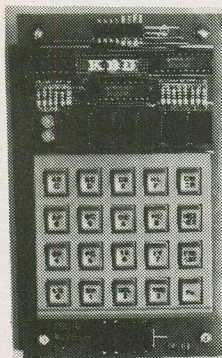
The usual precautions with AC wiring must be observed. In particular, remember that, although the 555 is on a 12V supply, that supply is superimposed on 120 V AC above ground. The switch and the 470nF capacitor must be types designed for high voltage operation.

### SELF-SUFFICIENT EPROM COPIER/PRO-GRAMMER



- Includes its own Z80-A processor
- Needs no personality module
- Copies: 1, 2, 4 & 8K bytes single supply EPROMs
- Comes with a powerful 4K bytes monitor

**ONLY \$99.00 \* (kit)**



With this KBH interface, you can modify your EPROM content or load a new code in the PRO-GRAMMER's RAM before transferring on EPROM. You can also access several operation modes such as:

- Memory and register examine and change
- Insert/delete one or many bytes anywhere in a program
- Break point execution mode
- Block transfer mode
- and much, much more

**ONLY \$59.00 \* (kit)**

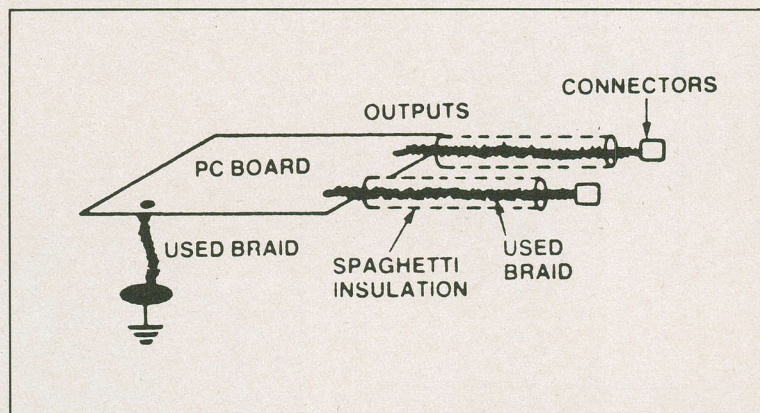
### FREE

Call or write for your free copy of the products catalogue manufactured by  
**PROTEC MICROSYSTEMES INC.**  
725 Decarie Suite 202, St-Laurent, Que. H4L 3L4  
(514) 744-3363.

\* Add 3% shipping and handling, Quebec residents: add 9% P.S.T. Cheque, money order, visa accepted. Please print your name, visa no, expiration date & signature.

Circle No. 12 on Reader Service Card.

### Reuse spent solder braid Peter Alter



Don't throw away those used pieces of Dri-Wick or other brands of desolder braid. It is an excellent, very low resistance conductor.

It can be used as a ground strap from circuit boards and connectors to the chassis or central earth point. Covered by spaghetti or heat shrink tubing, it makes an ideal low impedance lead for power supplied and amplifiers etc.

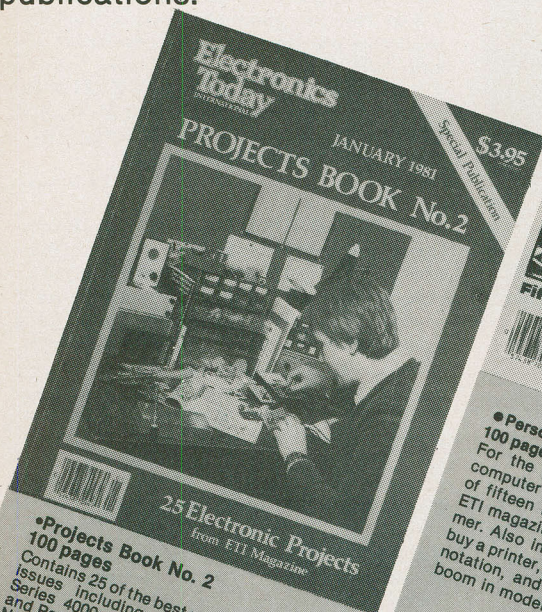
It has much lower resistance than hook-up wire, doesn't cost anything, and being rigid makes a good supporting strengthener for the pc board.



# ETI Special Publications

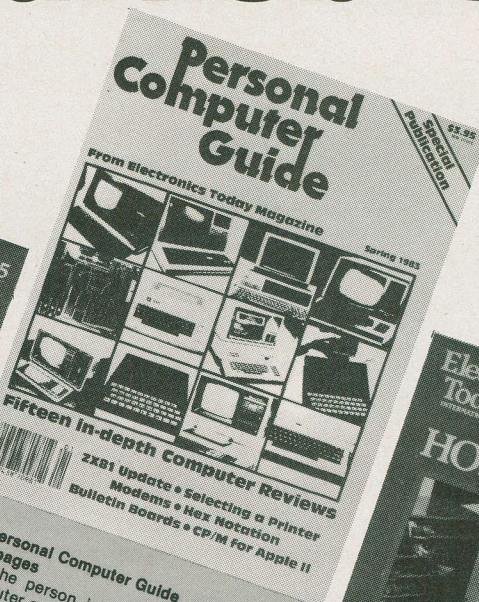
If you enjoy ETI, why not try some of our highly successful special publications.

Available from  
your favourite  
newsstand, elec-  
tronics store, or  
direct from ETI at  
Suite 601, 25  
Overlea Boulevard,  
Toronto, Ontario  
M4H 1B1. Please  
add \$1.00 for  
postage and  
handling.



**•Projects Book No. 2**  
100 pages  
Contains 25 of the best projects from recent issues including the High Performance Series 4000 Amplifier (including Preamps and Power Supply), Rumble Filter, Dynamic Noise Filter, Logic Probe, Cable Tester, Function Generator, Rain Alarm, Digital Tacho, Two Octave Organ, Light Chaser, Shutter Speed Timer, NI-Cad Charger, and more. First published January 1981.

\$3.95



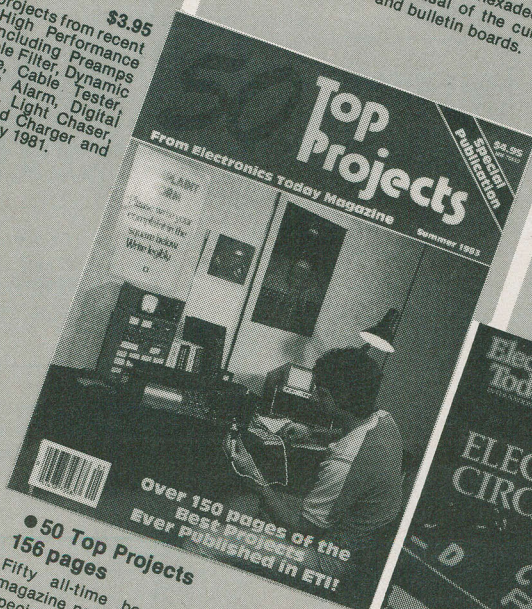
**•Personal Computer Guide**  
100 pages  
For the person interested in choosing a computer system of their own. A collection of fifteen in-depth computer reviews from ETI magazine, as composed by Steve Rimmer. Also included are articles on how to buy a printer, the intricacies of hexadecimal notation, and an appraisal of the current boom in modems and bulletin boards.

\$3.95



**•Hobby Projects**  
100 pages  
First published Summer 1980. Contains 25 straight-forward projects most of which have never appeared in the magazine including: Stereo Amp, Audio Mixer, Scratch and Rumble Filter, Constant Volume Amp, Graphic Equaliser, Envelope Generator, White Noise Effects Unit, Linear Scale Ohmmeter, Intercom, Drill Speed Scale, Electronic Organ, Parking Meter Timer, Dice, Siren, Simple Receivers.

\$3.95



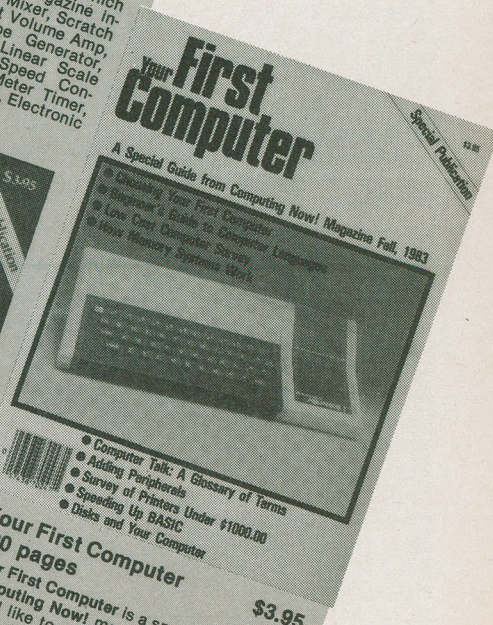
**•50 Top Projects**  
156 pages  
Fifty all-time best projects from ETI magazine packed into one giant 156 page special. There are projects for the beginner to the more advanced builder, including: Semiconductor Tester, Universal Counter, LED Level Meter, AM radio, and much, much more.

\$4.95



**•Electronic Circuit Design**  
92 pages  
A collection of major articles on various aspects of circuit design including CMOS, Audio Amplifiers, Power Supplies, SCR's, Op-Amps. Using the 3080 and Temperature Control. A large number of useful circuits are given but the emphasis is on guidance and how to design for yourself.

\$3.95



**•Your First Computer**  
100 pages  
Computing Now! magazine is a special guide from would like to get into computers for people who know where to begin. The publication includes articles on buying your first computer, buying a computer secondhand, a section on computer languages for beginners, surveys of computers and printers under \$1000.00, and a complete glossary of computer terms.

\$3.95



# CLASSIFIED ADVERTISING

ETI's classified advertising section allows you to reach about 30,000 Canadian readers nation-wide for \$1.00 per word. For as little as \$20 per insertion (there's a 20 word minimum) you can promote your business from coast-to-coast.

## WHAT DO YOU DO?

Send us your typewritten or clearly printed words, your permanent address and telephone number and your money (no cash please). Make your

cheque or money order payable to 'ETI Magazine'. We're at Unit 6, 25 Overlea Blvd., Toronto, Ontario, M4H 1B1.

## WHAT DO WE DO?

We typeset your words (and put the first word and your company name in BOLD capital letters). If we get your message by the 14th of the month, it will appear in ETI 1 1/2 months later. For example if we receive it by October 14th you (and thousands more) will see it in the December issue.

**DIGITAL ORGAN KITS** for sale. Demo LP (\$8.00) and free brochure available from **SELTRON INSTRUMENTS**, 35 Southbridge St., Leamington, Ont. N8H 4N4.

**SATELLITE T.V.** project July, Aug., E.T.I. Hard to get parts, Ga As Fets, microwave P.C. board, LNA's downconvertors, dishes etc. Send S.A.S.E. to **COLESAT SYSTEMS**, RR#2, Tantallon, N.S. B0J 3J0.

**DIGITAL** interfaced DC motor speedcontrol. 8bit in, DC out at up to 20amps. Great for robots and automation with micros. **SERVO-AMPLIFIERS INC.**, P.O. Box 568, Station A, Toronto M5W 1E4.

**PLANS** to build your own backyard satellite dish and pay-TV decoders. Send a S.A.S.E. to: **J.C. SYSTEMS INTERNATIONAL**, Dept. 306, 7305 Woodbine Ave., Markham, Ont. L3R 3V7 for free information.

**TI-99/4(A) OWNERS!** - Original games on cassette. Send for free list. **GIGO SOFTWARE**, Box 673, Niagara Falls, Ontario L2E 6V5 Canada.

**SAVE** money on breadboard, LED's, resistors, multimeters and much more. Send for your free flyer. **P & O DISTRIBUTORS**, P.O. Box 1293, Stn. E., Victoria, B.C. V8W 2W3.

**PRINTED CIRCUIT BOARDS** for ETI and Ham Radio projects. NDFL Amplifier - \$6.70; Green house sprinkler - \$4.65; Noise Reduction Unit - \$4.10; Spectra Column - \$7.85; Precision Pulse Generator - \$9.50. Full list free. Boards from ARRL Handbook 1983 available. Post and pack \$1.00, Ontario tax 7%. **B-C-D ELECTRONICS**, P.O. Box 6362, Sta. F., Hamilton, Ontario. L9C 6L9.

**APPLE-CLONE CIRCUIT GUIDE.** Full schematics, waveforms and tutorials. Essential for servicing, and interfacing. \$18.95. **INTERACTIVE MICROTRONICS**, Box 358, Pinawa, Man. R0E 1L0.

**DID YOU BUY THE WRONG COMPUTER?** We buy and sell used and new computers. We have one of Toronto's BEST Technologists on staff. Fully equipped computer service on premises. APPLE types our specialty! **GENERAL ELECTRONICS**, 5233 Yonge St., Willowdale, Ont., (416) 222-3626.

**6502 System Computer**, 64K memory, multi-function numeric keyboard, upper-lower case, with 12" green monitor, 1 disk drive with controller, Z-80 card, Apple™ and CPM™ software compatible. All for \$1250, shipping included. Send certified cheque or M.O. Ont. Res. add 7% Sales tax. **APL MICROWARE**, P.O. Box 21, Oakville, Ontario L6J 4Z5.

**COMPUTER** programming aid — A 16 bit Dec/Bin/Hex slide convertor \$3.75 ea. **R. HARDER**, 995 Shakespeare Ave., North Van., B.C. V7K 1E7 (\$16.25 for 5 conv).

**SPECIAL Resistors** — 100/\$1.00; Capacitors — 20/\$1.00; Diodes — 15/\$1.00; Transistors — 15/\$1.00; list - products & kits - \$0.50 for postage. All orders add 10% for P/H, Ont. res. add 7% p.s.t. Send orders to: **ELECTRON COMPUTERS**, P.O. Box 613, Stn. 'U', Toronto, Ontario M8Z 5X9.

**PORTABLE AM and FM Booster Antennas.** Tested speakers, surplus tubes and other radio parts. List/order from: **ELDON ELECTRONIC ENTERPRISES**, 10653 - 137A Street, Surrey, British Columbia, Canada V3T 4J7.

**AMAZING** Electronic Projects and Devices. Ultrasonics, hand held disrupters, repellers, lasers, battery pocket sized, high-powered, tesla coils, force fields, atomic, surveillance, mini-transmitters, plus much more. Catalog \$1. Mail orders only. **DUKER ENTERPRISES** 8932 - 155 St., Edmonton, Alta. T5R 1W4.

**INDUSTRIAL CONTROL COMPUTER.** 8085 based, on board Eprom, RAM, RS232, power supply. Able to upload, download data or programs from host or development system. 26 I/O lines, 16 of them buffered for 500ma/at 35V DC. Bare board + doc. \$39.95, complete kit \$115.00, Ass. + tested \$140.00. **ELECTRONIC SPECIALTIES**, 7794 Kittridge Dr., Mississauga, Ont. L4T 3J6.

**6809** with 64K, 2 serial and 2 parallel ports, 5" DS/DD floppy controller, on 2 Eurocard-size boards. Write for brochure. **SARDIS TECHNOLOGIES**, 2261 East 11th Ave., Vancouver, B.C. V5N 1Z7.

**RADAR** detectors (both bands), descramblers (sync., inverted video and variable), phasors, lasers, surveillance equip., satellite dishes, and lots, lots more. Catalogue \$2 refundable. No cheques. **F.T.S. ELECTRONICS**, Box 574, Brantford, Ont. N3T 5N9. Same day service.

**ZX81** Interface kit, featured in April ETI \$34.95. New low prices on following items. Expander for experimenters, adds two 22/22/.156 and one 23/23/.1 connectors to the Timex/Sinclair buss \$19.95. Also ZX81 video amp, adds composite video output \$4.95. Add \$2.00 P&H each order. **JDC 5-14 Sentinel Rd.**, Downsview, Ont. M3M 2Y5.

**ZX81-TIMEX 1000.** Word Sinc II. Professional word processing with ZX or Timex Printer. Print 42 UPPER and lower case letters per line. 20 special characters. Typewriter keyboard, all keys repeat. 60 wpm typing speed. Full screen editing. Text justification. Commands to: page; list; delete; move; replace; tab; expand print. Super fast flicker free machine code. Exceptional program. \$19.50. Super Data Save, Save Verify and Load named programs, or Data Files, at 14 times Sinclair speed. Many additional features. Comes with superior filter and manual. Almost a disk drive. \$54.25. Tactile Feedback Keyboard Overlay, Feel your keys. \$4.50. **P. HARGRAVE**, Site V, RR 4, Nanaimo, B.C. V9R 5X9.

**SCANNER** Crystals, \$7.50 each state freq. and make. B.C. Freq. Manual \$10.00. Parts Galore; Educational Kits. Cat. \$2.00. Allow 6-8 wk. delivery. **GLENEAGLES ELECTRONICS**, 1896 Springhill Dr., Kamloops, B.C. V2H 5J3. Phone 372-9604.

**EXPERT** services offered in Micro Electronics design, PCB layout and stuffing with quick turnaround by: **PERPETUAL MOTIONS ENT.**, 2643 Kennedy, Scarborough M1T 3H5, 293-4864.

**SURF** Board owners, now you can have detailed service schematics. Send \$20.00 certified cheque or M.O. payable to **G. STYRNA**, P.O. Box 13055, Kanata, Ont. K2K 1X3.

**SEND** me \$2.00 for Christmas, I'll send you my catalog with Timex Sinclair Computers. **COMPUTER SOURCE CENTRE**, P.O. Box 3637, Station A, Ottawa, Ont. K1Y 4J7.

**STUDENT** discounts on resistors, capacitors, I.C.'s, semiconductors. Pick up your free HOBBIIT catalogue at the store: 7454 Langelier, St. Leonard. Tel: (514) 259-5581. Or mail your name and address to **HOBBIIT ELECTRONICS**, 7303A Dumesnil, St., Leonard, Que., H1S 3A7.

**HAS** your DMM or Frequency meter TALKED TO YOU lately? If not, then you need FREQUENTALKER™! Imagine: you don't have to look up while measuring. It tells you in plain English what's on the display. Easy interfacing to any digital equipment (please specify with order). Send \$129 to **microNOVA ELECTRONICS**, P.O. Box 1284N, Halifax, N.S. B3K 5H4.



**APPLE™**-builders need "APPLE-SEED"! Comprehensive step-by-step instruction manual for assembling your microcomputer kit. 60 pages, 70 illustrations. Send \$9.95 (includes postage) to: **NUSCOPE ASSOCIATES**, P.O. Box 742, Stn. B, Willowdale, Ont. M2K 2R1. Quantity discounts.

**COMMODORE 64** owners. We offer a fine selection of programs. Send for free catalogue. **SANDISON SOFTWARE**, Box 1403, Chatham, Ontario, N7M 5W8.

**MULTIFLEX** owners: Screen oriented operating system, editor and software development tools for Z80A system. Canadian made video terminals also available. **ZEMOS SYSTEMS LIMITED**, 7225 Woodbine Ave, Suite 110, Markham, Ontario L3R 1A3.

**CORONET ELECTRONICS**, 649A Notre Dame W., Montreal, Que. H3C 1H8, Catalogue IC's, Semi's, Parts, send \$1.00 to cover postage. Monthly specials at crazy prices.

**TIMEX-SINCLAIR** Software and Hardware. Brand name products at incredible prices! Send for FREE catalogue-price list. **TORONTO SOFTWARE WORLD**, Box 84, Dept. E, Agincourt, Ontario. M1S 3B4.

**HYDROGEN GAS GENERATOR** plans and starter kit, \$12. **PRAIRIE POWER RESEARCH AND DEVELOPMENT**, P.O. Box 8291, Edmonton, Alberta. T6H 0L0.

**NEW** catalogue of components available. Get on our mailing list for regular bits and bytes specials. **M.O. ENTERPRISES**, Box 2066E, Bramalea, Ontario. L6T 3S3.

**J&J ELECTRONICS Ltd.**, P.O. Box 1437E, Winnipeg, Manitoba R3C 2Z4. Surplus and Semiconductor Specialists. Do you get our bargain flyer? Send \$1.00 to receive the current literature and specials and to be placed on the mailing list for future publications.

**WSI RADIO** — SWL Radios — Ham radios 18 Sheldon Avenue North, Kitchener, Ontario N2H 3M2. Tel. (519) 579-0536. Write for 1983 catalogue, \$2.00 (VE3EHC).

**VIC20** owners! - Say goodbye to 'OUT OF MEMORY' messages! Memory Module 16K for \$59; or expand your system to its full RAM capacity with Module 32K for \$99. Send to **microNOVA ELECTRONICS**, P.O. Box 1284N, Halifax, N.S. B3K 5H4.

## Tech Tips

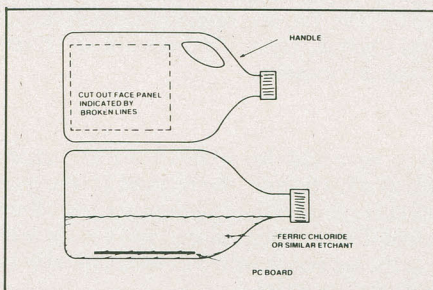
### Etching tank N.F. Bush

A discarded plastic bottle is a simple, but effective, etching tank.

I was recently making up several pc boards and found that I did not have a suitable etching tank. The containers which I have used on other occasions were flimsy and etchant was always spilt all over the place. So I grabbed an old bottle and cut it out as shown on the diagram.

I was amazed at how successful it was as I could move it around and didn't spill a drop.

The used etchant can be discarded easily by unscrewing the lid and pouring it out. There's not much mess to clean up afterwards and the bottle can be washed thoroughly and stored until needed again.



### Flashlight Communicator Chris McRae

This simple, portable, visually-aligned transceiver is quite effective and can be easily built into a flashlight.

The lamp current, modulated at an audio frequency, modulates the light beam. The light beam is detected by a photodarlington transistor and drives a small speaker for audio output.

The lamp is driven by an ac signal which cuts the RMS voltage to about one-third of the six volts, which is why a 1.5 V bulb is used in a 6 V circuit.

The photodarlington can be mounted on the axis of the beam or you may get better sensitivity by placing it so that it faces the reflector of the flashlight just above the bulb (the bulb filament is at the focal point of the reflector).

Fidelity is not high due to the low pass characteristics of the bulb filament, but I have been able to have intelligible conversations at distances up to 30 metres.

## Quality Boards & Kits All Apple™ Compatible

### PC-1000 Basic on your command

**\$650.00**

monitor  
disk drive  
not included



Featuring:

- \* 94 function keys
- \* 10 user programmable keys
- \* all keys self repeatable
- \* auto line feed
- \* upper/lower case cap lock

### PC-5500 • 64K PERSONAL COMPUTER

- 188 FUNCTION KEY
- 10 USER DEFINE KEY (KEEP MEMORY 5 YEARS)

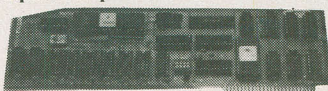


DISK DRIVE EXCLUDED.

**\$850.00**

### New Printer Buffer Card

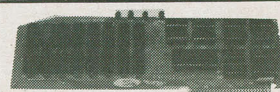
- \* High Res. Graphic Dump
- \* Expandable Buffer (16K-64K)



### 128K RAM CARD

Soft-ware  
not included.

Christmas Special **\$195.00**



### New 6502 Mark IV 64K RAM plus built in Z-80

- |                            |                     |
|----------------------------|---------------------|
| *Disk Controller Card      | ***Micro Modem Card |
| *80 Column Card            | ***8088 Card        |
| *New EPROM Programmer Card | ***6809 Card        |
| *New RAM Card              | ***A/D D/A Card     |
| **Communication            | SCS System          |
| **6522 Via Card            | ***Clock Card       |
| **Music Card               | Telephone Dialer    |
| ***RGB Card                | Video Telex System  |
| ***Speech Card             | Light Pen           |
| ***Super Serial Card       | ***128K RAM         |
| ***Buffer Printer          |                     |

Price for above PCB \*\$10.00 ea., \*\*\$15.00 ea.,  
\*\*\*\$25.00 ea., kits also available.

JOYSTICK • MINI FAN • 3M DISKETTE  
• DISKETTE STORAGE BOX • HEAD CLEANING  
DISKETTE • ZENITH MONITOR • AMBER MONITOR

Terms: Send cheque or money order (allow 2 weeks for personal cheques). Credit cards welcome. No C.O.D., Quebec Res. add 9% sales tax. Min. order \$10.00. Add 5% for shipping and handling, except Case & Power Supply. 20% restocking fee for returned merchandise. Prices and availability subject to change without notice. Do not send cash.

Dealers Inquiry  
Welcome



## FUJICOMP INC.

6420 Victoria Ave., Suite 3,  
Montreal, Quebec. H3W 2S7  
Tel. (514) 733-5612

Circle No. 34 on Reader Service Card.



## Brother EP-20 Electronic Typewriter

as "g" or "y", or letters with descending accents, will ride up a bit higher than the rest. On the other hand, a 5 x 7 print head keeps the cost down.

### Calculating

In the upper right corner, you'll find five buttons marked with the usual calculator functions. A typewriter with a built-in calculator? So it is. As you're typing up a storm, you can do four-function calculations up to 12 digits and print them along with the text. If you just want to calculate without actually printing it, you can switch to the non-print mode. There's a Clear key next to the LCD readout, but it has to be used with care, because it likes to print out the contents of the buffer before clearing the display. The delete key can be used to get rid of unwanted characters if you've been calculating and don't want numbers printed.

Other features include a Repeat key which repeats the last character entered, including Return and Backspace, which have auto-repeat anyway. The Tab and Margin functions are set electronically; just space to the desired point and press a button. Up to 16 tabs can be set. There is no visual indication of where the margins or tabs are located.

### Summary

A number of people, including other reviewers, have said that while the EP20 is an interesting toy, it has no real uses. I didn't find this at all. Here are the reasons I have one:

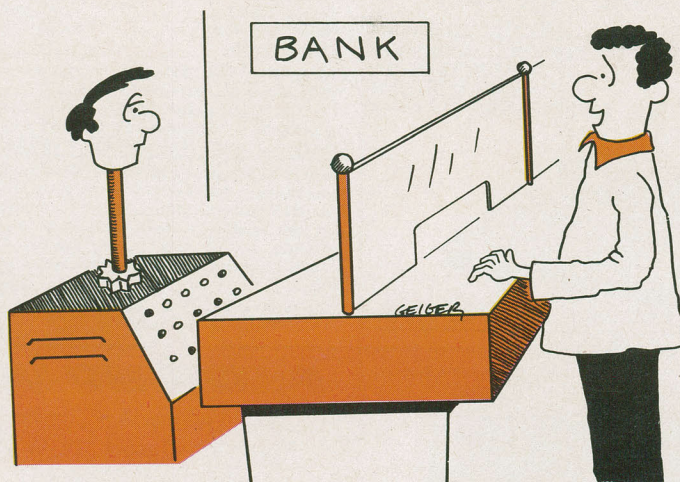
First of all, for the same price as the average electric, you get the 16-character correction feature. This may not sound like much, but I've found that the main reason I use a word processor is to be able to instantly correct typing errors as they happen; it would be nice to be able to manipulate text, but that's unlikely to be available for the price.

Secondly, the machine is easily portable and fits in a small space. I've never really wanted to type on a bus or airplane, but I like being able to slide the typewriter into a bookcase when desk space is needed; you can't easily do this with most portables.

Thirdly, the EP20 is virtually silent in operation. This means that you can type late at night or when someone is listening to the stereo.

On the negative side, there's the high cost of replacing the ribbon cassettes. Brother has a thermal paper available which eliminates the need for a ribbon, but the thermal quality isn't up to the excellent quality of the ribbon printout. The return function is very slow, presumably to reduce strain on the tiny motor; this wasn't a serious drawback. I wasn't too keen on the smoked acrylic print head cover; it tended to obscure the text for quite a few lines, and you couldn't leave it off because the platen rollers are incorporated into it.

But these points don't detract from the fact that the EP20 is one of the best applications of microcircuitry I've seen in a long time; it's a pleasure to own and use one.



*"I'm so glad I found a bank that still gives personal service. I hate those impersonal automatic tellers."*

## Where to Buy



## Digital / Analog Multimeters

Fluke 70 Series Digital/Analog multimeters are available in Canada through the Jet Stock program of Allan Crawford Associates Ltd., or from the following distributors:

### Vancouver, B.C.

R.A.E. Industrial Electronics Ltd. 291-8866  
Instrument Service Laboratories Ltd. 278-4511

### Victoria, B.C.

Queale Electronics Ltd. 388-6111

### Nanaimo, B.C.

Queale Electronics Ltd. 758-8166

### Vernon, B.C.

Interior Electronics Ltd. 545-2394

### Kelowna, B.C.

Interior Electronics Ltd. 860-0585

### Kamloops, B.C.

Interior Electronics Ltd. 374-5002

### Edmonton, Alta.

Cardinal Industrial Electronics Ltd. 483-6266  
Instrument Service Laboratories Ltd. 463-7488

### Calgary, Alta.

Cardinal Industrial Electronics Ltd. 259-6817

### Regina, Sask.

Radio Supply & Service Ltd. 352-8642

### Winnipeg, Man.

Wes Electronics Ltd. 632-1260

### London, Ont.

C.M. Peterson Co. Ltd. 434-3204

### Toronto, Ont.

Electro Sonic Inc. 494-1555  
C.M. Peterson Co. Ltd. 247-5437  
Armatek Controls Ltd. 251-3111  
Transmatron Canada Inc. 675-5980

### Peterborough, Ont.

Weesco-Peterborough 745-2493

### St. Catharines, Ont.

C.M. Peterson Co. Ltd. 685-7377

### Kitchener, Ont.

C.M. Peterson Co. Ltd. 745-0981

### Sarnia, Ont.

C.M. Peterson Co. Ltd. 344-3382

### Windsor, Ont.

C.M. Peterson Co. Ltd. 253-1161

### Hamilton, Ont.

C.M. Peterson Co. Ltd. 528-0151

### Thunder Bay, Ont.

C&F Electronic Distributors Ltd. 345-6515

### Sudbury, Ont.

Sonic Northern Ltd. 674-0764

### Timmins, Ont.

Sonic Northern Ltd. 264-1228

### Sault Ste. Marie, Ont.

Sonic Northern Ltd. 254-1418

### Ottawa, Ont.

Electronic Wholesalers Ltd. 746-4413

### Montreal, Que.

Electronic Wholesalers Co. Ltd. 769-8851  
Franklin Electric Canada Ltd. 341-6260

### St. Jean, Que.

Produits Electroniques en Gros  
(St. Jean) Cie. Ltée. 348-4961

### Chicoutimi, Que.

Franklin Electric Canada Ltd. 545-8313

### Noranda, Que.

Simtronique Inc. 762-1874

### Halifax/Dartmouth, N.S.

Weesco-Maritimes 465-3730

### St. John's, Nfld.

Rideout Tool & Supply Ltd. 745-2240



# The Digital vs. Analog battle is over.

**\$125\*** buys you the new champion. **The new Fluke 70 Series.**

They combine digital and analog displays for an unbeatable two-punch combination.

Now, digital users get the extra resolution of a 3200-count LCD display.

While analog users get an analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Plus unparalleled operating ease, instant autoranging, 2,000+ hour battery life and a 3-year warranty.

All in one meter.

Choose from three new models. The Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own multipurpose protective holster and unique "Touch Hold" function (patent pending) that captures and holds readings, then beeps to alert you.

Each is Fluke-tough to take a beating. American-made, to boot. And priced to be, quite simply, a knockout.

So call for more information.

FROM THE WORLD LEADER  
IN DIGITAL MULTIMETERS.



#### Fluke 73

\$125\*

Analog/digital display  
Volts, ohms, 10A, diode test

Autorange  
0.7% basic dc accuracy  
2000+ hour battery life  
3-year warranty



#### Fluke 75

\$145\*

Analog/digital display  
Volts, ohms, 10A, mA, diode test

Audible continuity  
Autorange/range hold  
0.5% basic dc accuracy  
2000+ hour battery life  
3-year warranty



#### Fluke 77

\$185\*

Analog/digital display  
Volts, ohms, 10A, mA, diode test

Audible continuity  
"Touch Hold" function  
Autorange/range hold  
0.3% basic dc accuracy  
2000+ hour battery life  
3-year warranty  
Multipurpose holster

\*Suggested Canadian price including duty and federal sales tax. Provincial taxes extra.



## Allan Crawford Associates Ltd.

Test & Measurement Division

Toronto: (416) 678-1500 Montreal: (514) 731-8564 Ottawa (613) 722-7682  
Halifax: (902) 463-8640 Vancouver: (604) 294-1326 Calgary: (403) 230-1341  
Edmonton: (403) 451-4893

Circle No. 35 on Reader Service Card.



## Mathematics for Electricity/Electronics

ing. The section on peak/RMS follows. The explanation given here is not of the same calibre as the rest; I can understand the reluctance to get into a subject requiring a knowledge of statistics sampling, but there must be thousands of students and hobbyists who know only that peak equals RMS times 1.414, or at best, the root of the means squared.

This brings up another interesting point. The root of two is shown in this section as 1.414, yet some of the examples in the book have been worked out to eight decimal places or more. This is an impossible degree of accuracy, but on the other hand, it lets you know whether or not your calculator is bang-on, or whether you've hit it by a lucky accident.

Inductive reactance, basic capacitance, and basic transformers are well-explained, and lead into eight units which are concerned with the characteristics of RC circuits. The beginning unit of these covers the RC time constant. This one seemed to me to sum up even more than the RMS problem

the tightrope on which handbook authors teeter: if you insert clarifying text, you may get taken to task for overdoing things. If you don't, people will say that the equations are inadequately explained. With this in mind, I thought that there should have been a better explanation of why the mysterious 63.2% keeps turning up in time constants. At some point, the student will likely stumble across the fact that it derives from  $e$ , the base of the natural logs, but it would be nice to have it spelled out.

Now we get to the fun stuff. If you can get the hang of capacitive reactance, you're on your way to understanding impedances, and then it's only a step to complex circuit design. The author have wisely chosen the simpler formulas which read out in ohms; for example, the RMS sum of reactance and resistance yields the impedance in ohms. Now, I'm not saying that the  $j$  operator shouldn't be used instead; only that it's cumbersome, and delays being able to grasp the intuitive idea of impedance. Once you get the impedance concept stuck into your

head, it's only a matter of learning any necessary equations. Until then, the student may only be parroting symbols without knowing why.

The book ends with units on series and parallel LC circuits; the format is the same as those mentioned in the last paragraph. The appendices are jammed full of useful information; some of it a recap of the units themselves, and some of it additional.

This is a text that should be owned by anyone interested in electronics. The negative points mentioned are, of course, a difference of opinion as to how much supplementary text should be included in a reference book. The superbly organized layout makes it a pleasure to use, and even stimulates the reader into doing more research on a topic. Oh, yes, I almost forgot. Mr. Kirchhoff pointed out that voltage drops around a circuit add to the supply voltage, and that current is the same in all parts of a series circuit.

by Bill Markwick

ETI

### Organize Your Workbench With Our Binder Series

Should you decide to celebrate the coming of 1984 by cleaning up your workshop, we offer the usual ETI binder. It holds 12 issues which can be inserted or removed without cutting or punching.

In addition, we now offer our device for storing special editions, the Moorshead Publications Binder.

Who?

Moorshead Publications: now that we consist of ETI, Computing Now!, and Teaching Electronics and Computing, we decided that answering the phone with "ETI" just didn't make it.

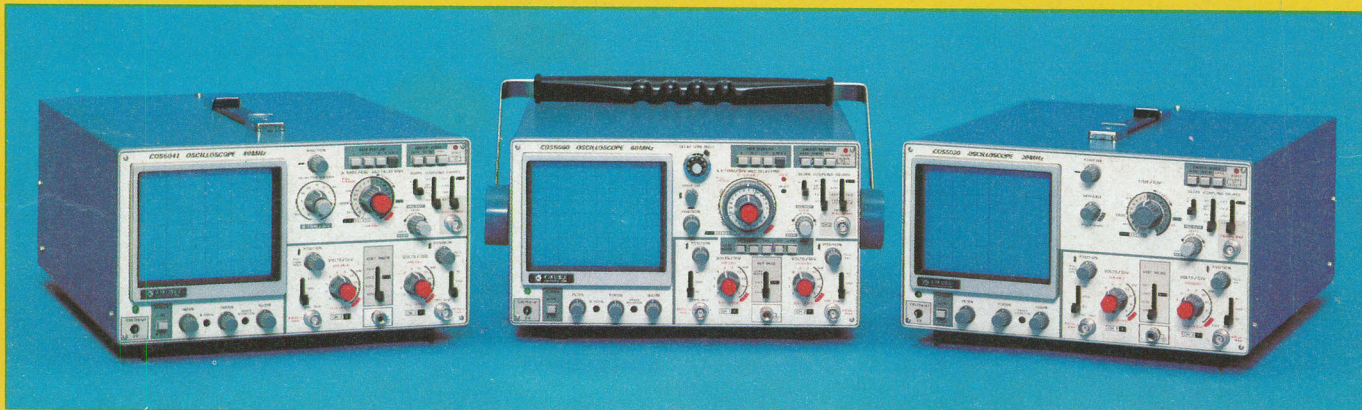
So — the binders are available for \$9.25 each, with an additional 7% sales tax for residents of Ontario (similar binders are available for Computing Now!; same price, same address).

Send to: ETI Binders, 25 Overlea Blvd., Suite 601, Toronto M4H 1B1.





# The best 60MHz scope costs only \$1725.00 It's from Kikusui.



That's right. Only \$1725 for Kikusui's top-of-the-line 5060 model oscilloscope. And we also have four other scopes for as low as \$895 in our new 5000 Series.

Not only that, we're offering a **two year warranty** on each of them, compared to other big name companies' limited one year warranties.

When it comes to performance, our 5000 Series has the edge over the Tektronix 2200 Series in lab quality, chop frequency, and trigger view. Ours also have more display modes, higher acceleration for better brightness, and sharper focus for better resolution.

Each scope in our 5000 Series is crafted so that it can be used for production, field service, consumer electronics servicing, or even personal use. The 5060 is a 60MHz scope with 3 channels, eight traces, delayed sweep, delay line and alternate sweep, and priced at \$1725. Models 5040 and 5041 are 40MHz, dual channel scopes, featuring peak-to-peak automatic triggering, automatic focus control and a delay line. If you're interested in a 20MHz scope, we have our 5020 and 5021 models with features similar to our 40MHz scopes. Both the 5041 and 5021 also have delayed sweep. Prices at \$1360 for the 5041, \$1145 for the 5040, \$965 for the 5021 and \$895 for the 5020. So, whatever model suits you best you can't get a better scope for the money.

Of course, there's a reason we're able to offer these bargains and quality. We're one of the biggest manufacturers of scopes in the world, with over 30 years in the business. Another reason is KIK's nationwide network of lab quality maintenance facilities.

Write us and we'll send complete specifications back to you. Or just take a little time to call us. It's a small price to pay to get big time quality and service.

Vancouver 604-430-1410 • Calgary 403-250-2034 • Ottawa 613-838-3397 • Montreal 514-336-0392 • Toronto 416-671-3920



SOLD AND SERVICED IN CANADA BY:

les systèmes

**interfax**

systems inc.

Clip and Mail

**ORDER FORM**

Name \_\_\_\_\_ Date \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ Prov. \_\_\_\_\_ Code \_\_\_\_\_

Phone No. \_\_\_\_\_

Amount Enclosed \_\_\_\_\_ ( ) M.O. ( ) Cheque ( ) Cert. Ch.

MAIL ORDER TO: Interfax Systems Inc., 3395 American Dr., Unit #12, Mississauga, Ont. L4V 1T5

SHIPPING: Courier collect preferred by Interfax, advise alternate method or pick-up at local Interfax office.

KIK COS5060	.....	1725.00	
KIK COS5041	.....	1360.00	
KIK COS5040	.....	1145.00	
KIK COS5021	.....	965.00	
KIK COS5020	.....	895.00	
		PLUS P.S.T.	
		TOTAL	

Price is in Canadian funds, duty & FST included, P.S.T. extra. Two probes & two year warranty included. F.O.B. Interfax System 3% discount for cash, cert. chq. or m.o.



**Imagine that there was a single source for all your Interconnection needs.**

There is. A P PRODUCTS has the most complete line of Interconnection products and accessories. DIP, Socket and Card-Edge connectors, all styles and sizes of Headers, and D-Submin in both IDC and solder versions. A P PRODUCTS offers flat cable in both gray and rainbow, in a wide variety of widths. And, our new low cost IDC assembly tool can help put everything together without putting a crimp in your budget.

**Imagine that you could find high quality IDC products at affordable prices.**

You can. A P PRODUCTS understands your prototyping needs. Our IDC products are manufactured to give you the accurate, dependable connections you must

have. They are designed to save you time. And, they are priced to save you money.

**Imagine that there's an easy way to find the A P PRODUCTS you need.**

There is. The A P PRODUCTS Interconnection rack at your electronics dealer has the complete line of connectors, cable, tooling, and accessories. Over one hundred and sixty products in all. You'll be able to find what you need fast. So you can get back to your project in a hurry.

**Imagine that you need more information.**

No problem. Just call Lenbrook Electronics. Markham, Ontario — (416) 477-7722  
St. Leonard, Quebec — (514) 323-3242  
Surrey, Vancouver — (604) 585-9599



# IMAGINE THAT



A P PRODUCTS INCORPORATED  
9450 Pineneedle Dr. • Box 540  
Mentor, Ohio 44061-0540  
(216) 354-2101  
TWX: 810-425-2250

In Europe, contact A P PRODUCTS  
GmbH • Baumblesweg 21  
D-7031 Weil 1 • West Germany

Circle No. 25 on Reader Service Card.

90P045395 0284 03  
K JOURNEAUX  
66 EASTON AV  
MONTREAL PQ H4X 1K8